



# Department of Energy

Oak Ridge Operations
Weldon Spring Site
Remedial Action Project Office
Route 2, Highway 94 South
St. Charles, Missouri 63303

August 7, 1987

ADDRESSEES

HYDROGEOLOGICAL CHARACTERIZATION REPORT

Enclosed are copies of the final report for the Hydrogeological Characterization Report for Weldon Spring Chemical Plant, Weldon Spring, Missouri.

Please distribute as appropriate throughout your agency.

Sincerely,

B. B. Nolger

R. R. Nelson Project Manager Weldon Spring Site Remedial Action Project

CE-541:Lawver

Enclosures

Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-810R20722

# HYDROGEOLOGICAL CHARACTERIZATION REPORT FOR WELDON SPRING CHEMICAL PLANT Weldon Spring, Missouri

July 1987



Bechtel National, Inc.

# HYDROGEOLOGICAL CHARACTERIZATION REPORT FOR THE WELDON SPRING CHEMICAL PLANT

JULY 1987

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-810R20722

Ву

Bechtel National, Inc.
Oak Ridge, Tennessee

Bechtel Job No. 14501

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## ACRONYMS

	AEC	Atomic Energy Commission
	BNI	Bechtel National, Inc.
-	BQL	Below Method Quantitation Limit
	CEP	Controls for Environmental Pollution, Inc.
	CHDP	Constant Head Double Packer Pressure Test
	CHSP	Constant Head Single Packer Pressure Test
	DA	Department of the Army
	DOE	Department of Energy
	EM	Electromagnetic Terrain Conductivity (survey)
	FH	Falling Head Test
	FUSRAP	Formerly Utilized Sites Remedial Action Program
	GMW	Groundwater Monitoring Well
	M-K	Morrison-Knudeson
	MODNR	Missouri Department of Natural Resources
	ORP	Oxidation Reduction Potential (REDOX)
	SFMP	Surplus Facilities Management Program
	TMA	Thermo Analytical
	TNT	Trinitrotoluene
	USGS	United States Geological Survey
	WSCP	Weldon Spring Chemical Plant
	WSSRAP	Weldon Spring Site Remedial Action Project
	WSOW	Weldon Spring Ordnance Works

#### ABBREVIATIONS

```
centimeter
CM
cm^2
                   square centimeter
                   corrugated metal pipe
cmp
                   centimeter per second
cm/s
                   Formation
Fm
                    foot
ft
ft^2
                    square foot
ft<sup>3</sup>
                    cubic foot
                    grams; gravity
g
                    gallon
gal
                    gallons per minute
gpm.
                    inch
                    liter
1
                    pound
16
lb/ft<sup>3</sup>
                    pounds per cubic foot
                    liters per second
1/s
                    ratio of length to time
L/T
                    meter
m
                    square meter
<sub>m</sub> 3
                    cubic meter
                    milliequivalents
meg
                    million gallons per day
mgd
                    milligrams per liter
mg/1
                    mile
mi
                    milliliter
ml
                    millimhos per meter
 mmhos/m
                    millivolts
 mν
                    picocuries per gram
 pCi/g
                    picocuries per liter
 pCi/l
 pCi/m<sup>2</sup>/s
                    picocuries per square meter per second
 pCi/m<sup>3</sup>
                    picocuries per cubic meter
                    picocuries per milliliter
 pCi/ml
                    parts per billion
 ppb
                    pounds per square inch
 psi
```

# ABBREVIATIONS

(continued)

psig pounds per square inch-gauge
pvc polyvinylchloride
s second
yd³ cubic yards
yr year

#### 1.0 INTRODUCTION

The Weldon Spring Chemical Plant (WSCP) is located in St. Charles County, Missouri, approximately 20 mi west of St. Louis, Missouri. Figure 1-1 presents the general location of the site and its relationship to major geographical features and population centers. A detailed plan of the WSCP's major buildings and features, including the raffinate pits, is provided in Figure 1-2.

In 1941, the U.S. Department of the Army (DA) acquired the site and surrounding areas for construction of the Weldon Spring Ordnance Works (WSOW). The WSOW operated from 1941 through 1944 and was engaged in the manufacture of trinitrotoluene (TNT) and related compounds. In 1946, the WSOW was declared surplus land, and parcels were transferred to various federal, state, and local agencies or sold to private concerns.

In 1956, the Atomic Energy Commission (AEC) acquired approximately 220 acres of the original WSOW from the DA for use as a uranium feed materials plant. The plant was operated as an integrated facility for the conversion of uranium ore concentrates and recycled scrap to pure uranium trioxide, intermediate compounds, and uranium metal. A relatively small amount of thorium was also processed. materials plant ceased operations in 1966. During the plant operating period, four pits were excavated for storage of raffinates from the plant. Following the shutdown of the feed materials plant in 1966, the AEC returned the facility to the DA in 1967 for planned use as a defoliant production plant [to be known as the Weldon Spring Chemical Plant (WSCP)]. The DA started removing equipment and decontaminating the buildings in 1968. The defoliant project was cancelled in 1969 before any herbicide was produced. retained the responsibility for the land and the facilities at the WSCP, but the tract encompassing the raffinate pits was transferred back to the AEC.

In November 1984, the Department of Energy (DOE) was directed by the Office of Management and Budget to assume responsibility for the WSCP from the DA. This transfer of responsibility occurred on October 1, 1985. The chemical plant was transferred from the DA to DOE for administration under its Formerly Utilized Sites Remedial Action Program (FUSRAP)/Surplus Facilities Management Program (SFMP) with caretaker support supplied by Bechtel National, Inc. (BNI). In 1986, the site (chemical plant and raffinate pits) became a separate remedial action project known as the Weldon Spring Site Remedial Action Project (WSSRAP) under a DOE contract with the M-K Ferguson Company.

This hydrogeological investigation is aimed at providing information for the siting of a disposal facility on the 220-acre site. The hydrogeological characterization plans and field work were completed by BNI during the spring, summer, and fall of 1986 under the FUSRAP/SFMP prior to the 1986 transition to the WSSRAP.

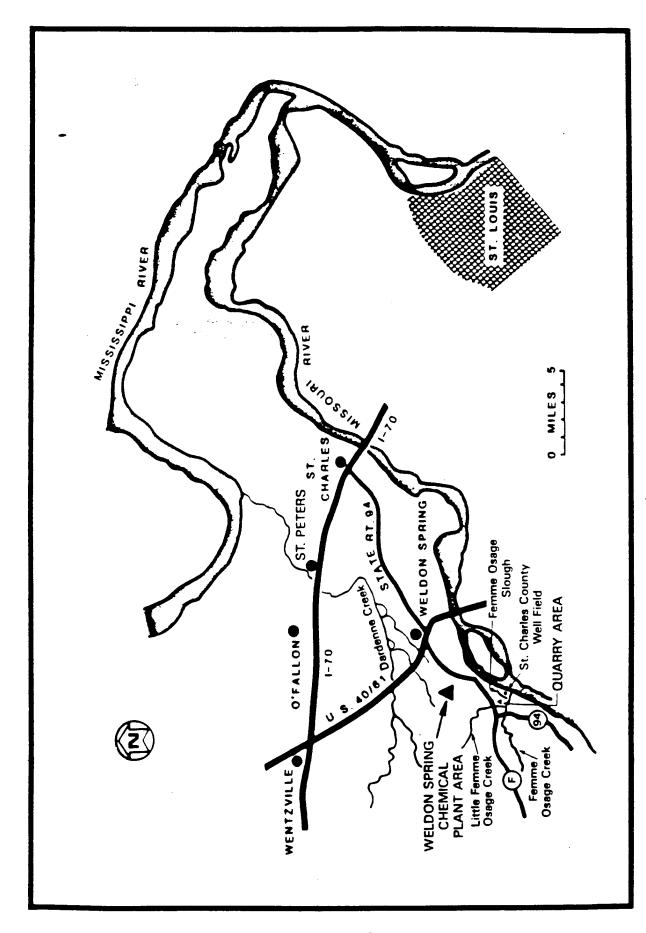


FIGURE 1-1 LOCATION OF WELDON SPRING CHEMICAL PLANT

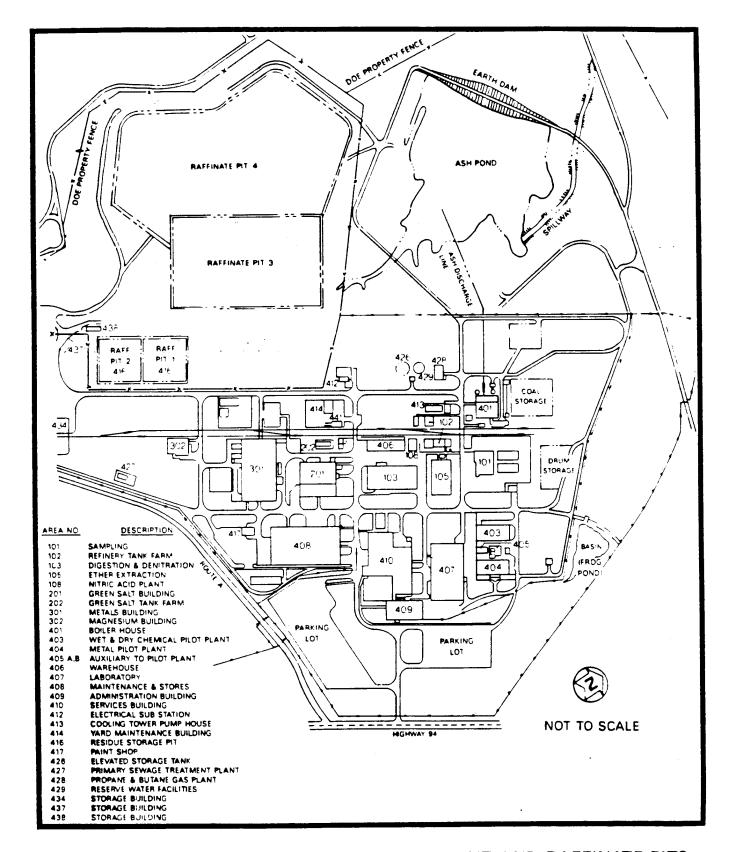


FIGURE 1-2 WELDON SPRING CHEMICAL PLANT AND RAFFINATE PITS (MAJOR BUILDINGS AND FEATURES)

#### 2.0 PURPOSE AND SCOPE

#### 2.1 PURPOSE

A hydrogeological characterization study was performed at the WSCP to meet two objectives:

- o Provide a groundwater monitoring system to determine if contaminants from the site have degraded groundwater quality.
- o Evaluate the site geology and hydrogeology for utilization of the site as a waste disposal facility.

#### 2.2 SCOPE

The site investigation included geophysical surveys, trenching, borehole drilling and sampling, installing groundwater monitoring wells, laboratory soil property analyses, and groundwater sampling and chemical analyses.

#### 3.0 PREVIOUS SITE INVESTIGATIONS

Site-specific geological and hydrogeological studies have been performed. These investigations include those by Fishel and Williams (1944), Roberts (1951), Lutzen (1967), Moylan and Elser (1967), the DA (1976), Lomenick (1982), Dean [1978, 1984 (two studies), and 1985], Berkeley Geosciences Associates (1984), and BNI (1984).

Fishel and Williams (Ref. 1) performed the first hydrogeological investigation of record, involving contamination of groundwater and surface waters by liquid wastes from the WSOW. This investigation concentrated on the migration of acid wash water and red water from the plant. The report concluded that the majority of the groundwater contamination resulted from surface runoff subsequently recharging bedrock and alluvial aquifers along Dardenne Creek. Roberts (Ref. 2) examined the site hydrogeological conditions prior to construction of the WSCP, for the AEC. This report focused primarily on providing baseline hydrogeological data and did not deal specifically with contaminant migration potential.

Lutzen (Ref. 3) evaluated seepage conditions at the raffinate pits and concluded that the low permeability of the soils would preclude any groundwater contamination by seepage from the pits. Moylan and Elser (Ref. 4) also evaluated the raffinate pits; although they found no evidence of seepage, they recommended installation of groundwater monitoring wells in the uppermost bedrock unit to allow early detection of groundwater contamination.

The DA (Ref. 5) evaluated hydrogeological conditions at the WSCP in its site assessment and concluded that vertical migration of contaminants would be minimal due to the low permeability of the soil. Dean (Ref. 6) pointed out that the DA data indicate the presence of a paleosink on the chemical plant site. He contended that this sink may act as conduit for contaminant migration to the groundwater system. He recommended that additional investigations be performed to evaluate potential contaminant migration pathways.

Lomenick (Ref. 7) evaluated the hydrogeological data for the raffinate pits area and indicated that no detectable quantities of radionuclides had migrated from the pit area, but he recommended additional borings and groundwater sampling to verify this conclusion. The Berkeley Geosciences investigation at the raffinate pits (Ref. 8) included the installation of seven groundwater monitoring wells placed to the top of bedrock. This study concluded that water in the raffinate pits is probably perched above the regional groundwater system and recommended that additional boreholes be drilled beneath the pits to allow evaluation of vertical seepage from the pits.

Dean (Refs. 9 - 11) performed dye tracing studies in the chemical plant area to determine the relationship between surface water and groundwater. The most significant finding of this investigation was that the drainageway from the plant ash pond was connected via the subsurface to the Burgermeister Spring area, a straight line subsurface flow distance of approximately 6,500 ft.

BNI (Ref. 12) performed a detailed geological investigation of the raffinate pits area. This investigation included geophysical surveys, trenching, drilling and sampling boreholes, installation of groundwater monitoring wells, and installation of piezometers. The finding of this investigation was that the raffinate pits site is suitable for long-term storage of residual radioactive materials.

#### 4.0 REGIONAL GEOLOGY

Elements of regional geology applicable to the geological characterization of the site are stratigraphy, structural geology, and-seismology.

#### 4.1 STRATIGRAPHY

# 4.1.1 Consolidated Materials

Figure 4-1 presents a generalized description of geological formations in the Weldon Spring area.

The oldest formations of interest are the Ordovician age Champlanian series. This series includes the St. Peter Sandstone, the Joachim Dolomite, the Plattin Limestone, the Decorah Formation, and the Kimmswick Limestone. The St. Peter Sandstone is composed of fine-to medium-grained, massive-bedded, quartzose sandstone. Overlying the St. Peter Sandstone is the Joachim Dolomite, which is a thin-to thick-bedded dolomite which grades into a siltstone (Ref. 13). The Plattin Limestone overlies the Joachim and is a thin-to thick-bedded, microcrystalline to fine-grained limestone. Overlying the Plattin is the Decorah Formation, which is a thin-bedded argillaceous limestone with intercalcated calcareous shales. A thin bed of metabentonite separates the Plattin and Decorah Formations. The Kimmswick Limestone unconformably overlies the Decorah and is composed of thick-bedded, high-purity limestone with local concentrations of chert (Ref. 14).

Overlying the Kimmswick is the Ordovician age, Cincinnatian series Maquoketa Shale. This unit pinches out northeast of Weldon Spring (Ref. 13) and is probably not present beneath the site.

South and west of Weldon Spring, the Kimmswick Limestone is unconformably overlain by the Upper Devonian age Sulfur Spring Group. This group is represented by the Bushberg Sandstone member

in the Weldon Spring area. The Bushberg Sandstone is a fine- to medium-grained quartzose sandstone with variable carbonate content (Ref. 14).

Unconformably overlying the Bushberg is the Early Mississippian age, Kinderhookian series Chouteau Formation. This formation is a thin-bedded limestone which contains a few shale partings and localized quantities of argillaceous material and chert (Ref. 14).

The Chouteau Formation is conformably overlain by the Mississippian age, Osagean series which includes the Fern Glen Limestone and the Burlington and Keokuk Limestones. The Fern Glen Limestone is a thin- to thick-bedded, crystalline to argillaceous limestone. Chert is common in this formation with occasional calcareous shale interbeds also occurring. The Burlington and Keokuk Formations are similar lithologically and have been grouped together by most investigators. These formations will hereinafter be referred to as the Burlington/Keokuk Formation. This formation is composed of limestone with abundant bedded and nodular chert. The limestone is very thin- to thick-bedded and crystalline, with grain sizes ranging from very fine to very coarse (Ref. 14).

Overlying the Osagean series are the Mississippian age, Meramecian series limestones which include the Warsaw Formation, the Salem Limestone, and the St. Louis Limestone. These units represent the stratigraphically youngest consolidated rocks in the Weldon Spring area. These units have been locally eroded away southwest of Weldon Spring (Ref. 13).

# 4.1.2 Unconsolidated Materials

Unconsolidated materials in the Weldon Spring area can be subdivided into five units:

- o Alluvial deposits
- o Aeolian deposits (loess)
- o Ferrelview Formation

- o Glacial till
- o Residuum

Alluvial deposits are primarily found in the Missouri and Mississippi River valleys and along major tributaries to these rivers. These deposits are typically composed of silt and clay of the Holocene epoch, underlain by sand and gravel of both the Holocene and Pleistocene epochs (Ref. 1). Thicknesses of the alluvial deposits range from a few feet to in excess of 100 ft along the Missouri River (Ref. 15).

Aeolian deposits are primarily loess (wind-deposited silt and clay) which was deposited during the Wisconsinan stage of the Pleistocene epoch. The loess deposits range from a slightly clayey silt to a silt and clay (approximately 50 percent of each). These deposits range from less than 5 ft to approximately 20 ft in thickness. The areal distribution of these deposits is typically limited to bluff tops and crests of divides (Ref. 16).

The Ferrelview Formation is a Pleistocene deposit composed of clayey silt. The preferred theory concerning the depositional environment for this unit is accumulation on a poorly drained till-plain surface. This unit is reported to range in thickness from 8 to 10 ft (Ref. 17). Since the Ferrelview Formation is related to the underlying glacial till, the distribution of the Ferrelview is also controlled by the areal distribution of the till.

Glacial till deposited during the Kansan stage of the Pleistocene epoch is present in the Weldon Spring area. The till is composed of clay, silt, sand, gravel, and cobble-sized particles. The glacial till has been subdivided into a clay till unit and a basal till unit based upon sand percentage and petrologic composition of the gravel/cobble fraction. The clay till unit is composed of clay with some sand, silt, and gravel. The gravel fraction is composed of quartz, chert, and igneous and metamorphic rocks. The presence of igneous and metamorphic rocks suggests a distal provenance for this till. The basal till unit is composed of chert cobbles in a sandy,

clayey silt matrix. The gravel and cobble fractions of this unit are almost entirely chert. The abundance of chert suggests a proximal provenance for this till. The areal distribution of glacial till in the Weldon Spring area varies and depends on the bedrock surface topography and the extent of glaciation in the area. Thickness of the glacial till varies from 0 (in areas of rock outcrop) to approximately 45 ft (Ref. 12).

The residuum is material resulting from in situ weathering of bedrock. Much of the Weldon Spring area is underlain by Mississippian age limestones. The residuum developed on these rocks is typically reddish-brown gravelly clay. The composition and percentage of the gravel fraction varies with the rock unit on which the residuum is developed. The residuum thickness varies from less than 4 ft up to 20 ft (Ref. 16).

# 4.2 STRUCTURAL GEOLOGY

The rocks in the Weldon Spring area have a regional strike of N60°W with a regional dip of approximately 1/2° to the northeast. The regional dip is a result of flexure from the Ozark dome (Ref. 14). Several small flexures have been noted in the Weldon Spring area; the nearest to the site is the Eureka/House Springs anticline. This flexure is located approximately 4 mi southwest of the site and trends northwest-southeast (Ref. 13).

Roberts (Ref. 2) identified two major joint sets in the Weldon Spring area: one set trending between N30°E and N72°E and a second set trending between N30°W and N65°W. Krummel (Ref. 14) indicates that the joint planes are vertical or nearly vertical.

All of the investigations in the Weldon Spring area have indicated that no faulting is evident in the exposed bedrock units.

# 4.3 SEISMICITY

The site seismicity and design earthquake considerations for the Weldon Spring area were previously evaluated by BNI (Ref. 18). The following paragraphs and figures summarize the results of the evaluation.

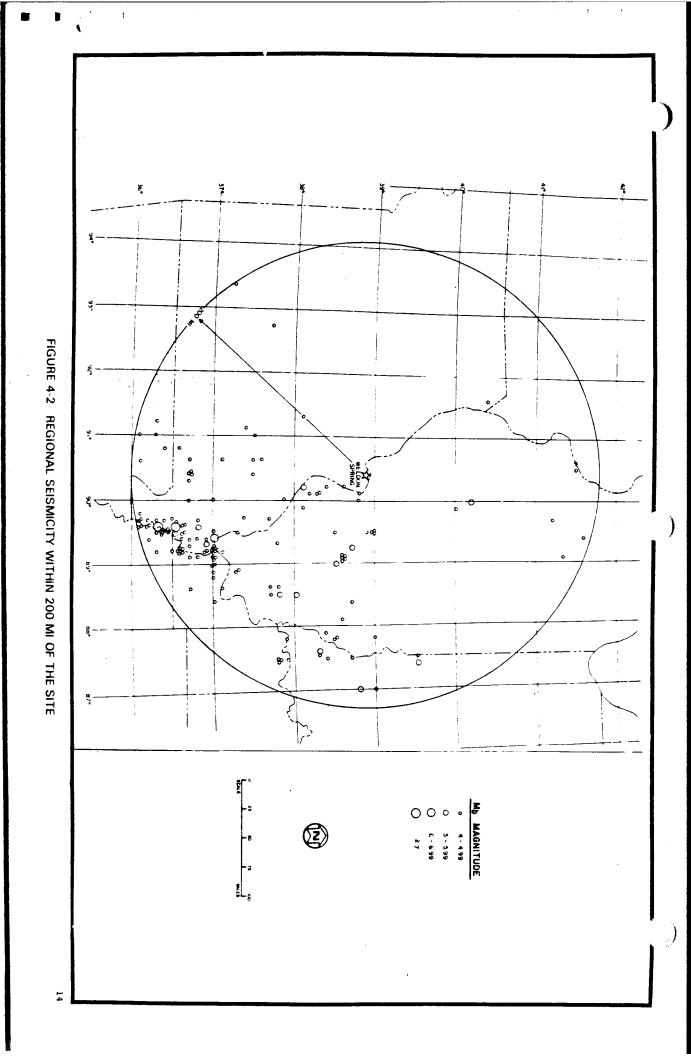
The Weldon Spring area lies within the tectonically inactive Central Stable Region near its boundary with the Mississippi Embayment. The Mississippi Embayment contains tectonically active areas with several fault zones present, including the New Madrid seismic zone. Figure 4-2, based on data from the National Geophysical and Solar-Terrestrial Data Center (Ref. 19), is a plot of regional seismicity within 200 mi of Weldon Spring. The New Madrid seismic zone is clearly defined by the seismic activity cluster located along the southeastern tip of Missouri.

Probabilities of peak dynamic accelerations and intensities have been evaluated for the Missouri area by Algermissen and Perkins (Ref. 20). They calculated accelerations with a 10 percent expectation during a 50-yr period (approximately equivalent to 475-yr accelerations). The results of their calculations are shown on Figure 4-3. Interpolation between contours indicates that the Weldon Spring area would have a gravitational acceleration of approximately 0.07 g at this probability level.

In addition to peak dynamic acceleration, estimates of maximum site intensity and body wave magnitudes were made. Estimates of maximum potential intensity range from VII to VIII on the modified Mercalli intensity scale. These values imply body wave magnitudes of about 5.3 to 5.8.

SYSTEM	SERIES	STRATICRAPHIC UNIT	DEPTH FROM DROUNC LEVEL TO TOF OF FORMA'SON, SH FEET	TYPICAL THICKNESS, IN FEET	BE SCRIPTION
	NOT DOZ NE	ALLUVIUM		10-30	GRAVELLY, STUTY LOAM ONTH OCCASIONALLY GRAVELLY, STUTY CLAY LOAM.
GLIATERNIARY				180-110	STETY LOAN, CLAY, AND SANE DVEP SAND AND GRAVELLY SAND.
	PLEISTOCENE	LOESS AND GLACIAL DRIFT	0	5-30 30-60	SHITY CLAT, SHLTY LOAM, CLAY, OR LOAM OVER RESIDULM AND BEDROCK, OR BOTH.
EMEAT ANI M		UND)FFERENT]A-	<b>6</b> -120	•	PARTLY SILTY RED SHALE WITH PURPLISH-RED TO LIGHT GRAY CLAY.
	BE RAME CIAM	\$1. LOUIS LINESTONE	0-120	70 - 75	LINESTONE: WHITE TO LIGHT GRAY, LITHOGRAPHIC TO FINELY CRYSTAL- LINE, NEDIUM TO THICK-BEDDED. CONTAINS SOME SMALE.
		SALEM LINESTONE	0-275	90-130	LINESTONE: LIGHT GRAY FO WHITE, FINE TO COMPSELY CRYSTALLINE, CROSS-MEDOED. SOME SILTSTONE AND SHALE IN LOWER PART.
OSSISSIPPIAN		WAPSAW FORMATION	<b>0</b> -345	70-90	CALCAREOUS SHALE: AND INTERMEDUCE SHALY LINESTONE, GRADES DOWN
		RECKUR AND BURLINGTON LINESTONES	0 - 405	160-700	LINESTONE: WHITE TO BEUISH-GRAY, NEDIUM TO COARSELY DRYSTALLINE, THICK-REDOED. CHERTY.
		FERN CLEN LINESTONE	<b>9-50</b> 0	50-70	LINESTONE: YELLOW-BROWN, FINE-GRAINED, NEDIUM- TO THICK-BEDDED.
	E INDERHOOK LAH	CHOUTEAU LINESTONE	0-580	50 70	DO. ONITIC ( ) NESTONE: GRAY TO YELLOWISH-BROWN, FINE-GRAINED, THIS-TO MEDIUM-BEDOED.
		REFURE RG SANCSTONE	0-625	3-15	DUART2 SAMOSTONE, REDDISH-BROWN, FINE - TO MEDIUM-GRAINED, FRIABLE
DE VONTAN	UPP(R	LOWER PART OF SUR PHUR SPRING CROUP UNC !!- FERENT LATED	0-625	35-40	CALCARLOUS SILTSTONE, AND SANDSTONE WITH DOLITIC LIMESTONE WITH SOME DARK, HARD, CARBONACTOUS SHALE.
	CINCINNATIAN	MAGUO ETA	0-650	30-50	CALCARCOUS OF DOLONITIC SHALE, TYPICALLY THINLY LAMINATED. SILTY WITH SHALT LINESTONE LENSES.
		KINNSVICE LINESTONE	0-710	90-100	LINESTONE: WHITE TO LIGHT GRAY, COARSELY CRYSTALLINE, MEDIUM: TO THICK-BLODED CHERTY MEAR BASE.
	CHAMPLAN) AN	DE CORAM FORMATION	D-810	30	INTERBEDDED GREEN AND YELLOW SHALE WITH THIN BEDS OF LINESTONE.
		PLATTIN LINESTONE	0-840	100-125	LINESTONE: LIGHT TO DARK CRAY, FINELY CRYSTALLINE. THINLY BEDDE MEATHERS WITH PITTED SUPFACE.
		JOACHIM DOLOM:1E	0-95c	90-110	DOLONITE, YELLOWISH-BROWN, SILTY, THIN- TO THICK-BEDDEC. GRADES THIO SILTSTONE, SMALES COMMON
		ST. PETER SMOSTONE	0-1070	120-150	DUAPT? SANDSTONE: YELLOWISH-WHITE TO WHITE, FINE- TO MEDIUM GRAINED, MASSIVE-BEDDED
ORDOVICIAN		EVERTON FORMATION	0-05¢	0	SANCT DOLOMITE.
		PCWE_1 DOLOWITE	0-950	50-60	DOLOMITE, MEDIUM TO FINELY CRYSTALLINE, OFTEN SANDY, OCCASIONALL CHERTY OR SMALT
		PTTER DOLONOTE	0-1250	200-250	DOLOMITE: LIGHT GRAY TO LIGHT BROWN, MCDIM-TO FINELY CRYSTALLIF DHERTY, ARGILLACEOUS, INTERMEDOCO WITH GREEN SHALE.
	CAMADIAN	JEFFERSON CITY DOLONITE	100-1500	160 180	DOLDMITE; LIGHT BROWN TO BROWN, MEDIUM TO FINELY CRYSTALLINE.
		ROLE 100UT FORMATION	350-1100	150 170	DOLOWITIC SAMOSTOME.
		GASCONADS DOLOWITE	500-1850	250	CHERTY DOLOMITE-CONTER MEMBER IS AREHACEOUS DOLOMITE.
		EMINENCE DOLOW: TE	750-2100	700	DOLOWITE: MEDIUM TO MASSIVELY BEDDEE, LIDHT GRAT, MEDIUM TO COARSE-GRAINET.
	<b>UPP</b> (R	P01051 90L0H11[	950 2250	100	DOCUMENTS, MASSIVE, THICKLY BEDDED, MEDIUM TO FINE-GRAIMEE. ABI DAM'S QUARTZ DRUSE.
P.4400 1 411		DERBY AND DOC RUN BOLDH: 1ES	1050-2350	150	DOLOMITE, THIM: TO MEDIUM-BEDDED ALTERNATING WITH THIN-BEDDED S STORE AND SHALE.
CMBRIAN		DAVIS FORMATION	1200-2500	170	CONTAINS SMALE, SILTSTONE, FINE-BRAINED SAMDSTONE, DOLOMITE, AM LINESTONE COMPLONERATE.
		BONDE TERREL BOX DM31E	1350 2650	400	DO. DMITE: TYPICALLY A LIGHT GRAY, MEDIUM: TO FINE-GRAIMED, MEDI BEDDED.
		L MICTTE SAMESTONE	1800-3100	450	PREDDITIONALLY QUAPTIONE SANDSTONE.
PRECAMBRIAN		2200 350c			IDME DUS MOCKS.

FIGURE 4-1 GENERALIZED STRATIGRAPHIC COLUMN OF THE WELDON SPRING AREA



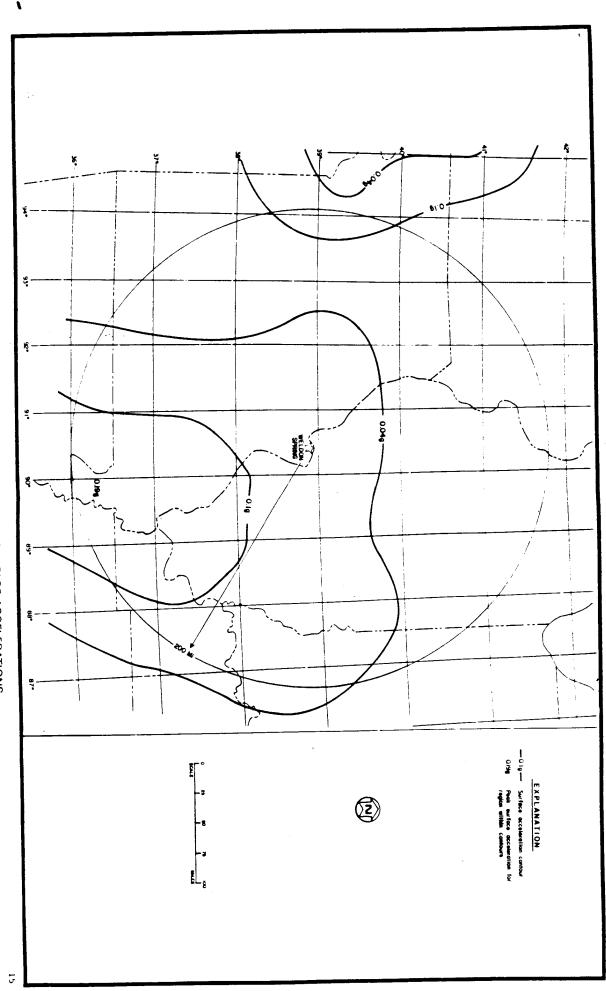


FIGURE 4:3 475-YR PEAK DYNAMIC SURFACE ACCELERATIONS

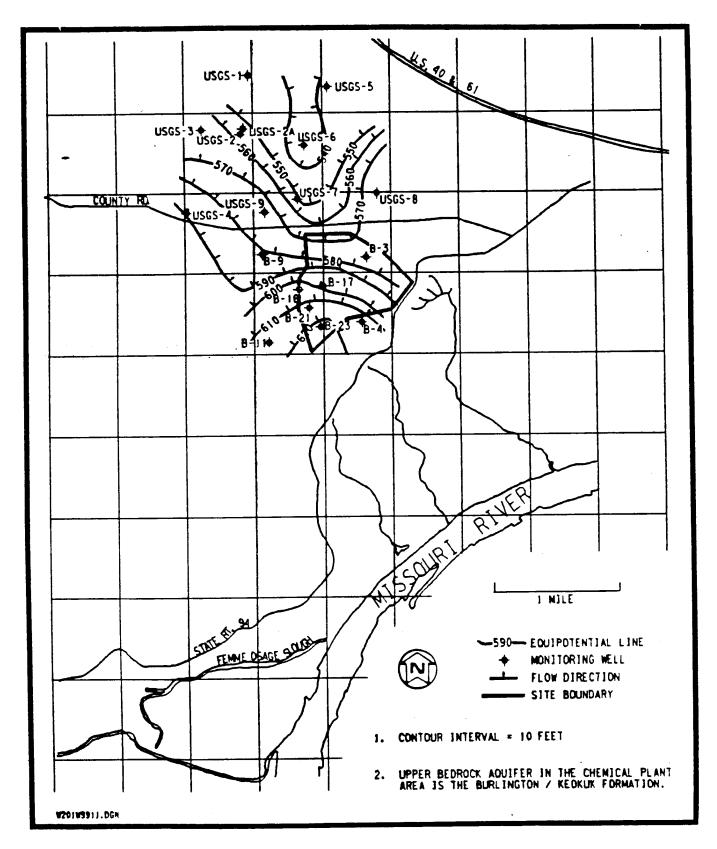


FIGURE 5-1 POTENTIOMETRIC SURFACE IN THE SHALLOW BEDROCK AQUIFER

# 6.0 SITE TOPOGRAPHY AND SURFACE DRAINAGE

The WSCP is located along the axis of the drainage divide between the Missouri and Mississippi River basins [Figure 6-1 (Ref. 24)]. The main plant area is essentially flat with a surface elevation of approximately 660 ft above mean sea level. Four topographic features dominate the chemical plant area. First, the man-made dikes for the raffinate pits extend up to 20 ft above the surrounding ground surface. The second and third features are the topographic depression in which the plant ash pond was constructed and the man-made dike at the northwest end of the ash pond. The fourth feature is a slope to the north along the northern margin of the chemical plant. This slope has been artificially exaggerated in the area of the steam plant to provide a level coal storage area and a depressed settling basin for the coal storage area runoff.

Surface water drainage from the site is controlled by the drainage divide mentioned previously. The southeastern portion of the chemical plant drains toward the Missouri River and the remainder of the site, including the raffinate pits and ash pond areas, drain toward the Mississippi River. Three major drainageways are present at the site. One drainageway receives runoff from the northeastern portion of the site and includes the settling basin known as the frog pond. This drainage enters Lake 36 in the Busch Wildlife Area and eventually enters the Mississippi River. A second drainageway receives runoff from the ash pond and raffinate pits area. This drainage enters Lake 35 in the Busch Wildlife Area and eventually enters the Mississippi River. The third drainageway, which was the sewage outfall for the plant, is located southeast of the plant. This drainage eventually enters the Missouri River.

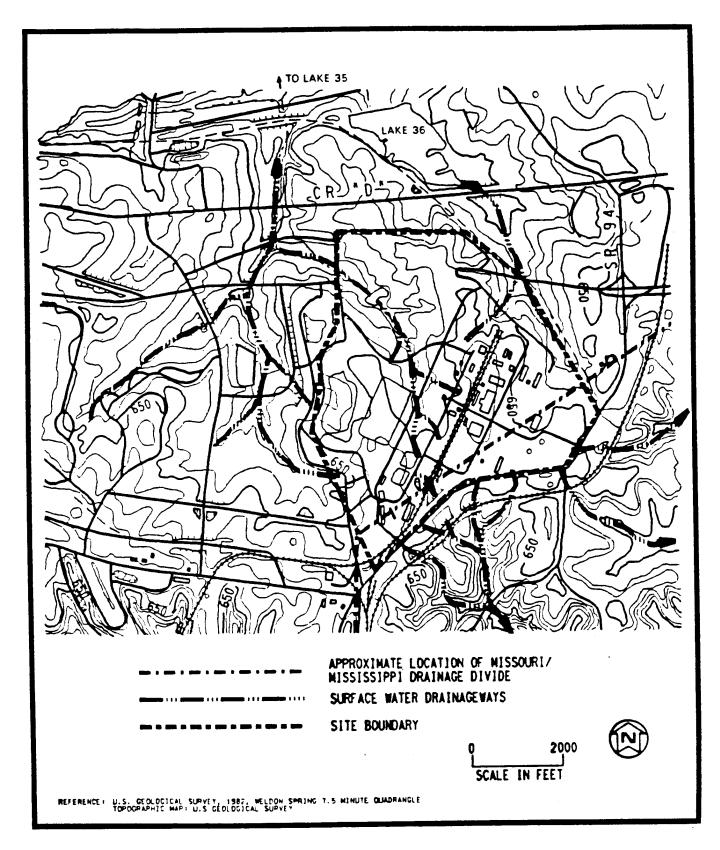


FIGURE 6-1 SITE TOPOGRAPHY AND DRAINAGE

#### 7.0 SITE GEOLOGY

The investigation of the site geology included performing a seismic refraction survey, drilling 34 boreholes, and excavating and backfilling five trenches. The locations of the investigatory data acquisition points are shown on Figure 7-1. Summaries of information collected from the borings and trenches are presented on Tables 7-1 and 7-2, respectively. Boring logs and trench logs are presented in Appendices A and B, respectively.

Borings were advanced through the overburden using hollow stem augers and were sampled using either a split-spoon sampler or a Shelby tube sampler. Rock core samples were obtained using an NO or NXB (3-in. diameter) wire-line coring apparatus. Trenches were excavated with a John Deere 410B backhoe and shored with hydraulic shoring prior to entry for wall mapping. All drilling and trenching activities were monitored and documented by BNI geologists. borings not completed as groundwater monitoring wells were backfilled with cement/bentonite grout to the ground surface. Trenches were backfilled with radiologically "clean" excavation spoils, which were compacted in average lifts of 1 to 2 ft by using the backhoe bucket. The trenches were backfilled with the "clean" materials to ensure that water infiltrating through these materials would be of higher quality than water infiltrating through adjacent ground.

Results of this investigation were integrated with the results of the previous BNI investigation (Ref. 12) to interpret the site geology. The data points from the previous investigation are also shown on Figure 7-1, and a summary of boring data is included on Table 7-1.

Hydrogeological cross sections of the site were prepared using stratigraphic information from the borings. These sections are shown on Figures 7-2 through 7-4.

#### 7.1 BEDROCK GEOLOGY

The uppermost bedrock unit underlying the site is the Burlington/Keokuk Formation. This formation is composed of fine- to coarse-grained limestone with abundant chert occurring as nodules and beds. Stratigraphic information from the borings indicates that the Burlington/Keokuk Formation can be subdivided into two units at The uppermost unit is highly to moderately weathered, highly to moderately fractured, yellowish-brown to white limestone, containing 40 to 60 percent chert. This unit contains solution features ranging from vugs (up to 2 in.) to small cavities (up to 5 ft). Cavities are generally filled with silt/clay/chert gravel mixtures but may occasionally be filled with sand/chert gravel mixtures. Both solution features and predominant fractures appear to be oriented parallel to bedding in the limestone. The variability in thickness varies from 19 to 42 ft in thickness. is attributed to variations in depth of weathering of the limestone. The underlying unit is a slightly weathered to fresh, slightly fractured, brownish-gray to gray limestone, containing 20 to 40 percent chert. Solution features are limited to occasional vugs in the upper portion of the unit. Stylolites (pressure solution features) and/or shale interbeds are common in this unit. In core samples, this unit appears massive and without horizontal fracturing. Core breaks generally occur along stylolites or shale This unit is thought to represent the unweathered interbeds. portion of the Burlington/Keokuk Formation.

Two seismic refraction (SR) survey lines were run (Figure 7-1) to evaluate variations in bedrock topography. SR Line 1 runs in the north-south direction east of Raffinate Pits 1 and 2; SR Line 2 runs primarily east-west and is located north of the ash pond. The results of these surveys are presented in Appendix C. The results of the surveys indicate that the top of bedrock, as defined from a borehole, could not be accurately delineated by the refraction survey. This results from an absence of significant seismic velocity contrast between the overlying residuum and glacial till

and the underlying weathered bedrock. The refraction method does appear to delineate the boundary between the upper and lower units of the Burlington/Keokuk Formation. The seismic velocity of the lower unit is approximately 2 to 3 times the velocity of the upper unit.

Boring information was used to generate a bedrock topography map of the site (Figure 7-5) to allow evaluation of the preglacial paleogeomorphology of the site. The bedrock topography contour map represents an interpretation of data collected from the boreholes shown on Figure 7-1. The contours are based on a finite number of data points, and thus varying interpretations or localized variations in the bedrock surface with dimensions that do not extend to the boreholes are possible. Previous investigations (Refs. 5 and 6) indicated the presence of a large circular depression in the bedrock surface centered adjacent to the steam plant. This feature was postulated to be a paleosink. Additional subsurface information collected during this investigation indicates that this feature is more extensive than originally defined. The bedrock topography map The feature appears indicates that this feature is a paleochannel. to trend with the regional joint orientation of N30°-65°W (Ref. 2). Information from several borings (GMW-7, B-20, and B-3) indicates a gravelly zone at the base of the residuum. This zone probably represents the residue from a weathered chert zone within the bedrock.

# 7.2 OVERBURDEN GEOLOGY

Figure 7-6 presents an isopach map of overburden thickness. The overburden isopach map is based upon a finite amount of boring data. The interpretation presented represents the results of evaluating the boring data with respect to the geology of the area. Additional boring information would allow further refinement of these contours or may suggest an alternative configuration. This map shows that, in general, the overburden thickness follows the bedrock topography, with the thickest overburden deposits present where the bedrock is topographically the lowest.

Stratigraphic information from the borings indicates that the overburden contains six units:

- o Residuum
- o Basal till
- -o Clay till
- o Ferrelview Formation
- o Loess
- o Topsoil/fill

The residuum is typically a red to yellow gravelly clay to gravelly silt. The gravel fraction is primarily composed of angular chert, with minor amounts of weathered limestone fragments. The thickness of the residuum varies from 0 to approximately 23 ft on the site. The areal distribution of the residuum varies and appears to be a function of localized weathering and erosional mechanisms.

Overlying the residuum in some areas of the site is the basal till unit. This unit is a yellowish-brown sandy, clayey silt with angular chert gravel and cobbles. Figure 7-7 presents an isopach map of this unit. The areal distribution of this unit appears to be controlled by bedrock topography, since the unit thins or is absent in areas with higher bedrock elevations and is thickest in areas of lower bedrock elevations.

Overlying the basal till is the clay till unit. The clay till is a yellowish-brown silty clay to clayey silt. This unit contains sand and gravel-size particles and pyrolusite (manganese oxide) veins and stringers. The gravel fraction is composed of subrounded to rounded granitic and mafic rocks and chert fragments. Figure 7-8 presents an isopach map of this unit.

Overlying the clay till unit in most areas of the site is the Ferrelview Formation. This unit is a dark yellowish-orange to brown color with gray mottling. The Ferrelview ranges from a silty clay to a clayey silt. Iron oxide nodules and pyrolusite veins and stringers are common in this unit. Figure 7-9 presents an isopach map of the Ferrelview Formation.

Loess deposits overlie the Ferrelview Formation, or where absent, the clay till unit. This unit is a mottled gray, dark yellowish-orange clayey silt to silty clay. The loess varies from 0 to 10.5 ft in thickness across the site. Areal distribution of the loess is quite variable due to predepositional topography and postdepositional erosion.

The topsoil/fill unit is the uppermost overburden unit at the site. The topsoil portion of the unit is a black, organically rich, silty clay or clayey silt. Topsoil thickness ranges from less than 0.5 ft to 1 ft. The fill portion of the unit is quite variable in composition. The source of the fill is thought to be primarily on-site soils which have been excavated, transported, and recompacted. The thickest areas of fill occur at the raffinate pit dikes, where up to 26 ft of fill is reported. Other minor areas of fill occur around the site, primarily for maintaining plant grade and drainage control.

# 7.3 OVERBURDEN CHARACTERISTICS

Disturbed (split spoon) and undisturbed (Shelby tube) samples of the major overburden units were submitted to Controls for Environmental Pollution (CEP) of Santa Fe, New Mexico, for soil testing. Results of the soil tests are summarized on Table 7-3, and test data sheets are presented in Appendix D. The data presented on Table 7-3 are broken down by individual units to examine variability within units and provide a comparison between units.

Comparison of grain size distributions of the four units indicates that the basal till has the highest gravel content, the clay till has the highest sand and clay content, and the loess has the highest silt content. The Ferrelview Formation contains a higher percentage of silt than the clay till does, yet the Ferrelview is thought to be derived from the clay till. The higher silt content of the Ferrelview may reflect loess deposited contemporaneously with the Ferrelview.

The two most critical parameters measured in the soil testing program were effective cation exchange capacity and distribution The clay till unit exhibited the highest cation exchange, followed by the Ferrelview Formation and finally the basal till. The-loess unit was not examined in this study due to its limited areal extent on the site. The results of these tests are as could be expected from the percentages of clay in each unit. The clay till has the highest clay content and thus has the highest surface area and largest number of surface charged particles available for exchange reactions to occur. The basal till has the least amount of clay and contains significant amounts of quartz and amorphous silica (chert) which provide less possibility for sorption reactions to occur. Distribution ratios were measured using a 10.44 mg/l uranium source solution. The results of the distribution ratio tests indicate the opposite results from the cation exchange capacity tests, with the basal till having the highest distribution ratio and the clay till having the lowest distribution ratio. Visual examination of the samples by laboratory personnel indicates that the basal till sample has the highest organic content of the samples tested. This suggests that the reactions observed in the basal till sample may involve complex formation and/or oxidation-reduction reactions created by the reducing conditions surrounding the organic matter, rather than by sorptive processes. The cation exchange capacity measurements show the basal till as having the lowest cation exchange capacity which indicates a low sorptive capacity of The implication of this reasoning is that the ability of the soil. the basal till to immobilize radionuclides is directly tied to organic content and the geochemical environment and may vary both spatially and temporally.

Seeley and Kelmers (Ref. 25) determined distribution ratios for uranium (VI) and radium-226 of five soil samples taken of raffinate pit dike fill and natural soil. Distribution ratios for uranium (VI) were determined using source concentrations of 5 mg/l and 10,000 mg/l. Distribution ratios for the 5 mg/l-source concentration ranged from 12 to 1,300 ml/g and for the 10,000 mg/l,

they ranged from 0.72 to 1.6 ml/g. Distribution ratios for radium-226 were determined using a source concentration of 100,000 pCi/ml and ranged from 660 to 18,000 ml/g.

In addition to the parameters measured by the laboratory, other relevant soil parameters were calculated for the Ferrelview Formation, the clay till unit, and the basal till unit. These parameters are also shown on Table 7-3. These data indicate that the Ferrelview Formation has the highest saturation, specific retention, and activity, and the lowest specific yield (Ref. 26). This is further supported by the work performed by Howe and Heim (Ref. 17) on the Ferrelview Formation. They state that construction experience with the Ferrelview has indicated that it has a very high capacity for moisture retention and that it tends to dry out very slowly.

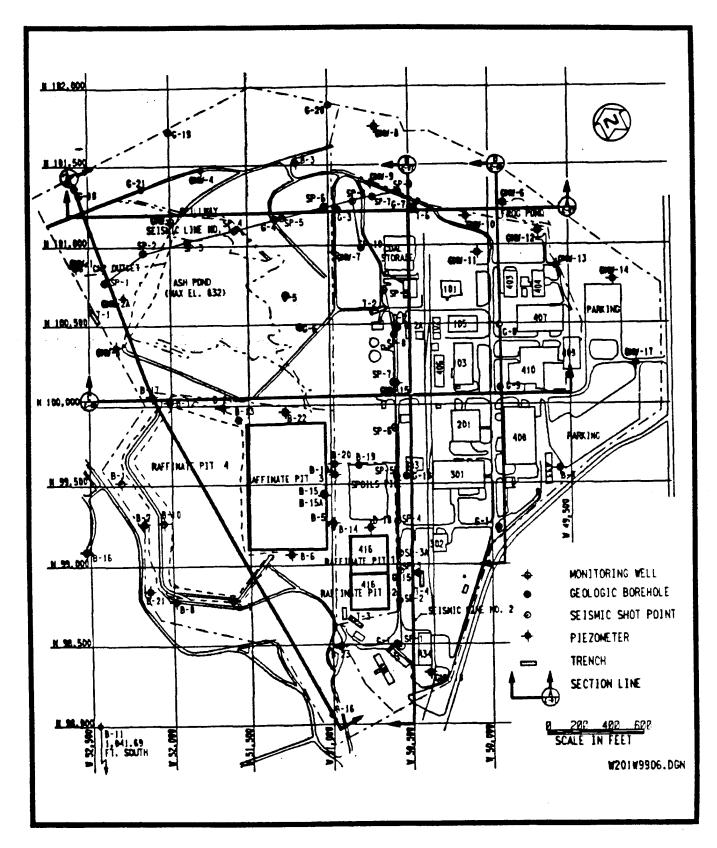


FIGURE 7-1 EXPLORATION LOCATION PLAN

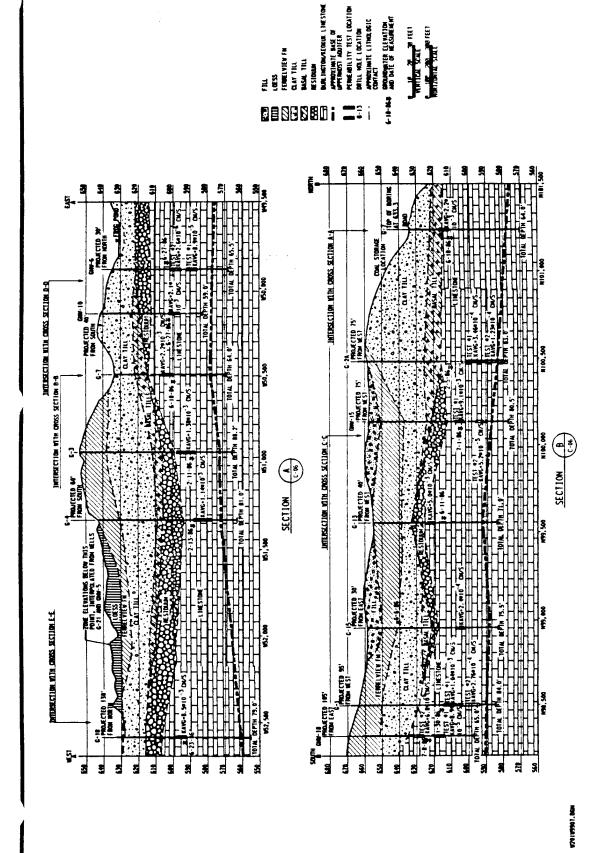


FIGURE 7-2 GEOLOGIC CROSS SECTIONS A-A AND B-B

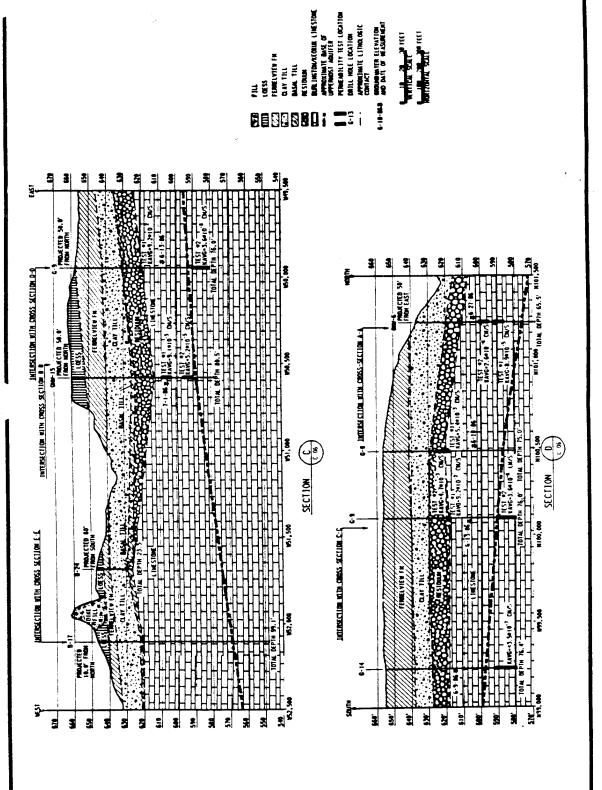


FIGURE 7-3 GEOLOGIC CROSS SECTIONS C-C AND D-D

RUFTIMIT PIT 4

JATERSECTION WITH SROSS SECTION C-C

INTERSECTION WITH CROSS SECTION A-A

PROJECTED 45.0"



FIGURE 7-4 GEOLOGIC CROSS SECTION E-E

W201 W3909, DGN

34

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1

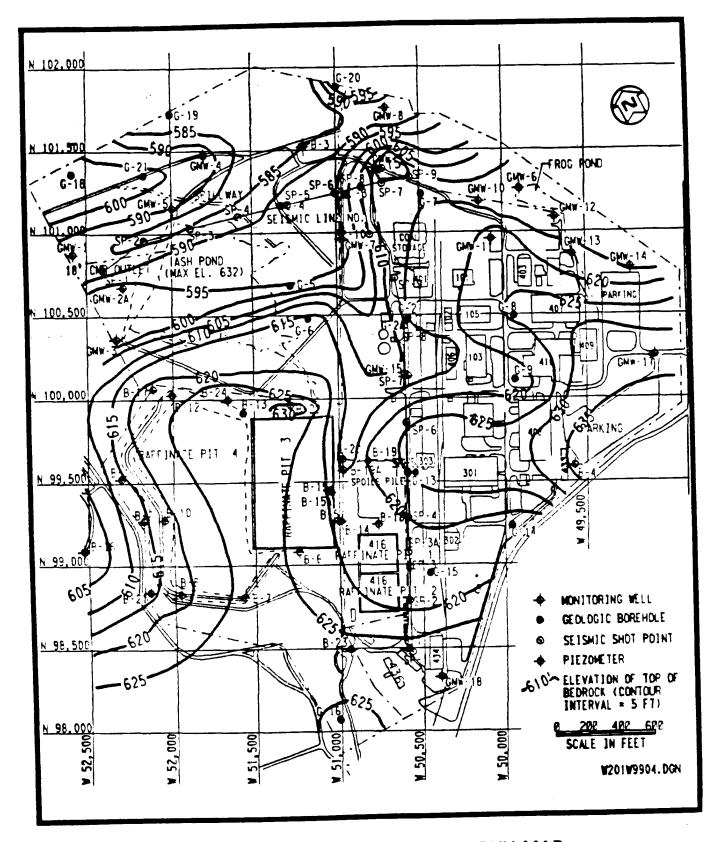


FIGURE 7-5 BEDROCK TOPOGRAPHY MAP

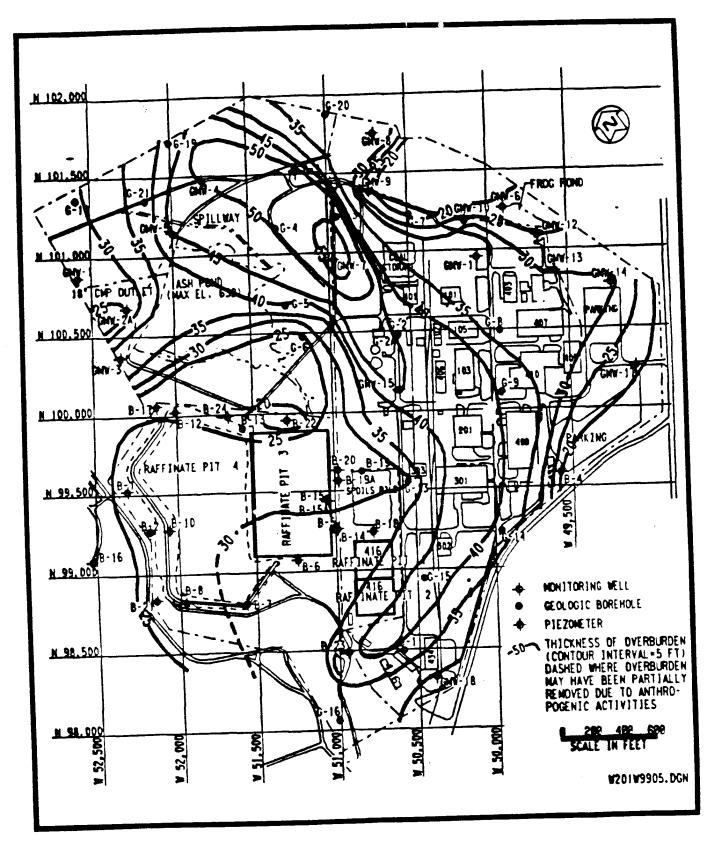


FIGURE 7-6 ISOPACH OF OVERBURDEN

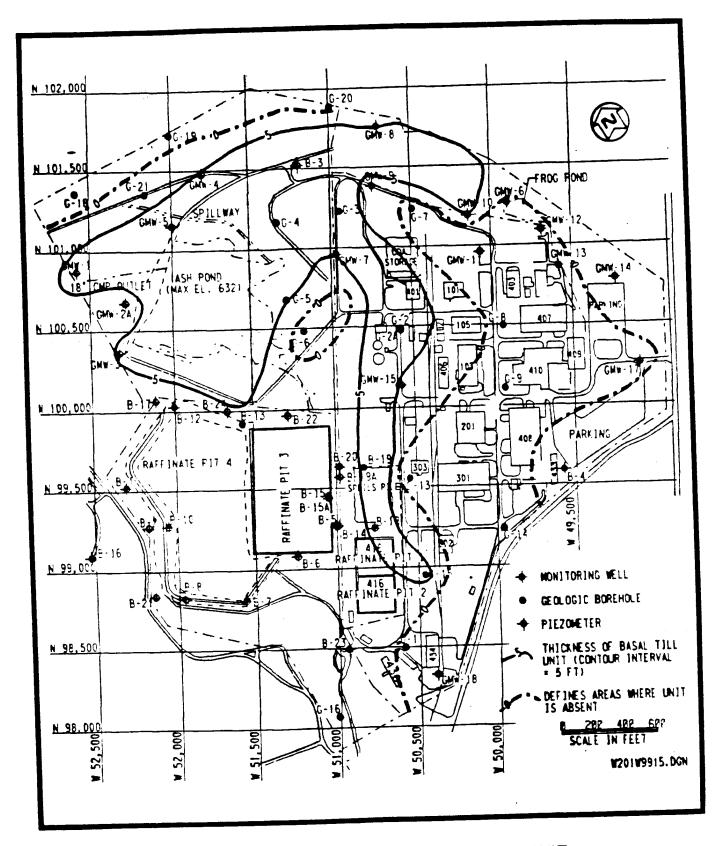


FIGURE 7-7 ISOPACH OF BASAL TILL UNIT

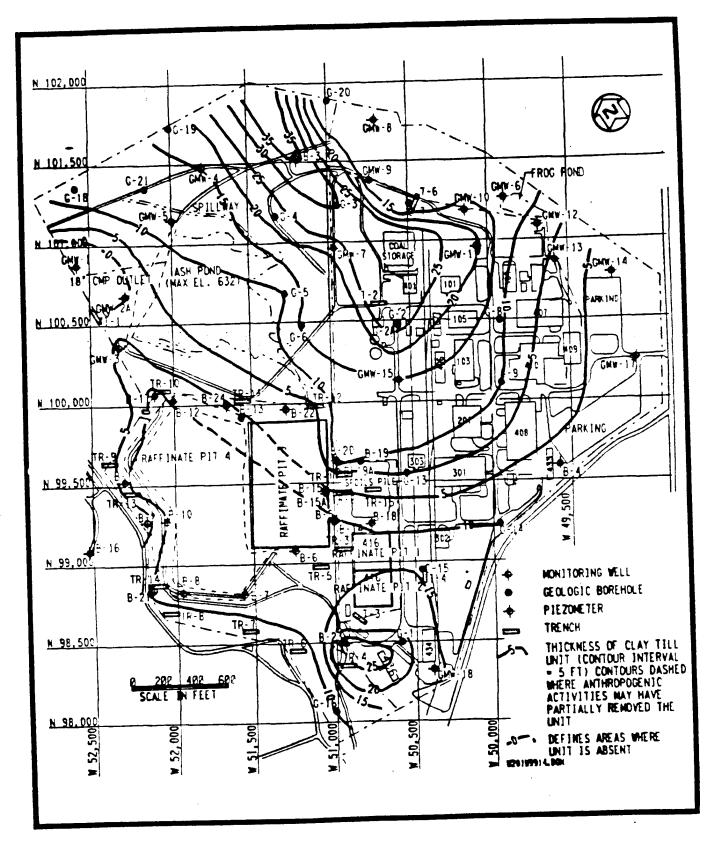


FIGURE 7-8 ISOPACH OF CLAY TILL UNIT

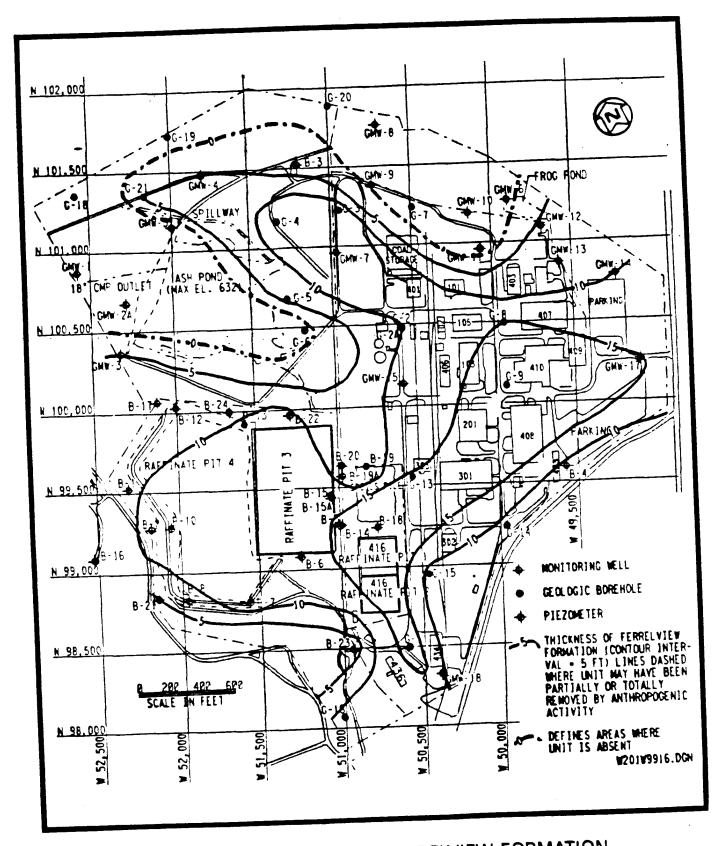


FIGURE 7-9 ISOPACH OF FERRELVIEW FORMATION

TABLE 7-1 BORING SUMMARY

8-1 8-2 8-3 8-4 8-5 8-5		West Coordinate <sup>b</sup>	Ground Elevation <sup>C</sup>	Overburden Thickness (ft)d	Residuum Thickness (ft)d	Too of Sound Rock (ft)d	Hole (ft)	Groundwater (ft)	Installation Date
8-1 8-2 8-3 8-4 8-5 8-5					1	1	21.5	Dry	02/16/83
8-2 8-3 8-4 8-6	99507.31	52283.25	638.84	, 6		1	29.6	22.6	02/21/83
	99255.75	52139.58	631.04	9.57	•	0.42	150.5	56.5	03/11/83
9 - 4 9 - 5 9 - 7	101532.61	51176.70	615.10	0.46	0	23.7	119.6	38.9	03/16/83
5 - 8 8 8 8 7 - 5 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	99548.26	49549.08	655.19	18.0	2.,		2		03/22/83
25 25 2 7 - 5 2	99235.26	50975.59	653.29	•	t	1 - 4. 1.	£ ::	10:0	F8/71/F0
7-83	99050.01	51224.33	663.72	ı	*	1	21.5	5.07	03/11/03
	98764.40	51596.95	658.17	ı	•		22.75	Dry	03/43/63
	96750 81	41969,06	646.68	0.72	ŧ		33.0	Dry	03/23/83
o (	16.06/84	00.00010	612.72	21.0	0	21.0	84.7	50.7	04/04/83
<u>6</u> -60	94848.34	72044 63	2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	•	ı	•	25.6	Dry	03/24/83
B-10	99257.19	29.046.62	665.65	ט ונ	0.9	23.0	106.2	63.5	03/29/03
B-11 ·	96958.31	52458.57	004.00	0.64		•	30.0	Dry	03/25/83
B-12	100003.42	51968.88	663.60	ŧ	ı	•	27.0	Dry	03/28/83
8-13	99890.22	51545.69	663.78	1	ı	•	21.83	22.1	04/08/83
8-14	99236.90	50965.65	653.53	1	1	<b>,</b> '	30.0	19.0	04/11/83
8-15	99420.65	\$1025.38	663.94	ı	1	•	37.0	Drv	04/11/83
8-15A	99410.29	51021.62	663.42	1	•	•	2 E	17.4	04/18/83
B-16	99084.02	52513.02	621.67	27.0	D. 88	1 6		42.0	04/12/83
B-17	100043.37	52082.13	645.64	29.0	3.93	0.67	1.66	בי	04/11/83
8-18	99218.80	50750.75	658.75	•	•	•	21.5	, A10	04/08/83
8-19	99596.66	50805.60	645.37	21.0	•	• ;		( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( ) ( )	04/25/83
R-19A	99546.41	50954.29	645.17	28.0	0.0	30.0	0.101		04/08/83
B-20	99597.59	50956.60	643.75	29.5	8.49	29.5	29.5		04/19/83
8-21	98832.52	52123.23	644.41	35.0	12.0	35.0	9.4.		04/15/83
B-22	9931.65	51266.71	647.36	15.0	ı	•	0.61		04/19/83
	98471.52	50936.42	665.09	38.0	0	36.0	7.06	36.0	04/15/83
2 - E	99969.03	51635.20	649.22	23.5	1	•	23.5	65.33	98/01/10
7 -	98473	50581	668.0	39.7	0	45.3	0.40	55.43	03/06/86
ָּבְּיִּבְּיִבְּיִבְּיִבְּיִבְּיִבְּיִבְּ	6490	S0578	658.0	42.5	2.3	44.8	83.0	53.20	96/69/96
6-2A	0000	64003	654.0	54.6	7.0	54.6	88.2	65.55	99/11/20
G-3	101195	64606		50.0	12.5	53.0	81.0	56.10	02/13/86
<b>7</b> -0	101141	96716	· · ·	0 C <b>T</b>	18.0	0.04	73.0	38.00	08/04/86
6-5	100650	51250	6.55.9		8.6	23.5	67.0	10.71	06/50/86
9-0	100450	51150	639.7	63.3					

(continued) TABLE 7-1

Borehole Number a	North Coordinate <sup>b</sup>	West Coordinate <sup>b</sup>	Ground Elevation <sup>C</sup>	Overburden Thickness (ft) <sup>d</sup>	Residuum Thickness (ft)d	Depth to Top of Sound Rock (Ft) <sup>d</sup>	Total Depth of Hole (ft)	Depth to Groundwater (ft)	Installation Date
7:	101 200	\$0450	633,3	18.5	7.0	18.5	64.0	34.20	06/18/86
<b>a</b>	100450	00000	655.3	30.0	4.0	34.3	75.0	52.12	06/10/06
, <del>,</del>	100065	49905	656.0	37.5	11.5	37.5	76.0	49.47	06/16/86
֓֞֞֜֜֜֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓	99521	50517	654.7	28.5	6.5	28.5	71.0	31.08	06/12/86
	00100	49915	655.8	37.5	10.0	- 37.5	76.4	41.40	98/60/90
יין אַ טרן אַ	98924	50447	658.0	41.0	0.4	41.0	75.5	18.10	98/90/90
91-19	98051	51007	656.7	34.0	0.6	34.0	80.4	30.10	98/50/90
) E	101350	52551	633.8	29.0	11.5	36.0	79.0	41.00	06/23/86
61-5	101700	51950	619.4	41.5	12.7	41.5	0.99	40.50	06/24/86
G-20	101850	50950	630.3	32.5	16.0	32.5	66.0	44.30	06/23/86
G-21	101336	52116	638.7	34.2	7.2	54.0	74.5	\$2.00	07/31/86
GMM-1	100858	52554	612.1	26.5	11.8	26.5	60.0	23.30	07/14/86
GMW-2A	100658	52253	624.0	24.5	9.5	29.0	60.0	31.0	07/12/86
GMM-3	100347	52299	636.8	38.8	10.8	38.8	59.0	30.10	07/10/86
CMW-4	101450	51750	642.8	51.0	18.0	51.0	72.0	51.40	01/24/86
CHA-S	101131	\$1950	635.7	8.4	12.1	44.8	76.0	47.41	07/23/86
6MW-6	101223	49852	633.8	22.6	9.6	22.6	65.5	30.10	06/21/86
CHW-7	100928	50933	649.0	0.65	13.0	59.0	94.0	48.80	01/09/86
8-18-00 0-18-00	101720	50659	619.9	31.5	14.5	31.5	57.0	34.20	06/22/96
CHIM-9	101350	50700	636.7	20.5	5.5	26.5	54.0	39.00	06/36/96
GMW-10	101150	\$0100	642.1	29.5	6.0	32.8	59.0	40.00	06/21/86
CHW-11	100016	50030	653.0	32.0	5.0	32.0	74.0	52.00	06/30/86
GMW-12	101050	19643	636.2	25.5	5.5	25.5	0.09	40.00	07/02/86
CH-13	100819	49539	645.5	27.5	6.5	27.5	70.0	39.60	07/03/86
CMW-14	100715	49186	647.3	33.0	12.0	35.0	59.0	43.00	01/01/86
GMW-15	100100	50550	657.4	45.5	9.0	45.5	80.8	53.41	08/01/86
CHW-17	100200	49050	657.8	23.5	0	23.5	64.0	52.30	06/22/86
					1			07 00	A8/80/70

41

TABLE 7-2 TRENCH SUMMARY

Trench	Center Point	Center Point Coordinates <sup>a</sup> N W	Total Depth (ft)	Topsoil/ Fill	Average Clayey Silt. (Loess)	Average Unit Thickness (It) y Silt Ferrelview Glad sess) Formation Ti	(ft) Glacial Till	Residuum
T-1	100,546.5	52,437.5	15.0	0.8	4.2	ı	ı	10.0
T-2	100,555.5	50,662.0	15.0	9.0	2.2	8.9	5.4	ı
T-3	98,621.0	50,844.0	15.0	1.5	6.4	7.1	1	i
<b>₽</b> -	98,886.5	50,427.0	15.0	5.5	1	9.5	i	ı
T-6	101,206.5	50,411.0	16.0	2.4		1.3	11.3	I

acoordinates are based on the AEC coordinate system.

TABLE 7-3 SOIL TESTING SUMMARY

	2						
o ropolo	o Lume D	Depth Interval	Pe	Percentages of		Grain Sizes	
Number	Number	(ft)	Gravel	Sand		Silt	Clay
TINIT	E				• •		
	-	י ט	c	٤	: -	65	29
G-18	1 GG-1	3.5 - 5.0	<b>:</b>	: 1		<b>.</b>	ı
C-ZI CMW-1	SS-1		ı	ı		1	<b>1</b>
E-MW5	55-1	5.5 - 7.0	0	. 2		65	30
GMW-4	55-1	•	ı	ı		1 !	1 6
GMW-5	SS-1	.5 -	C	ស		29	87
GMW-7	SS-1	- 5	ı	ı		1 ;	1 (
GMW-11	SS-1	•	C	<b>.</b>		64	3. C
GMW-15	SS-1	.5	C	m		59	38
mean standard n	mean standard deviation n		0+0+2	4.4		64 +3 -5	31.6

TABLE 7-3 (continued)

Page 2 of 25	25				
Borehole Number	Sample Number	Depth Interval (ft)	Liguid Limit	plasticity Index	Unified Soil Classification
LOESS UNIT	E.			•	
G-18	1	- 5	ı	esk.	ı
G-21	55-1	3.5 - 5.0	1	4 f	ן נ
GMW-1	55-1	- 5	30	£. 1	רם י
GMW-3	55-1	.5 - 7		1	<b>!</b> !
GMW-4	58-1	.5 - 5	ì	t,	<b>i</b> !
GMW-5	SS-1	.5 - 5	ı	1	<b>;</b> '
CMW-7	55-1	.5 - 5	I	I	<b>!</b> !
GMW-11	55-1	- 5	ı	ŀ	ı
GMW-15	SS-1	3.5 - 5.0	l	f	ı
mean standard	mean standard deviation	c	1 1 -	1 1 -	1 1
c			<b>-</b>	٠.	1

TABLE 7-3 (continued)

Page 3 of 25	25				
		Denth	Specific	Unit Weight	eight
Borehole S Number	Sample Number	Interval (ft)	Gravity (q/cm³)	Dry (1h/ft <sup>3</sup> )	Wet (1b/ft3)
LOESS UNIT					
81-5		3.5 - 5.0	1	t ·	
G-21	58-1	3.5 - 5.0	2.58	<b>I</b>	F
	טטיין		ĵ	<b>†</b> .	<b>t</b> (
C MMS	CC_1	5 5 1 7 0	1	92.3	110.6
S-WES	1-00	) L	!	85.5	101.7
GMW-4	SS-1	 	l	0 2 2 0	106.9
GMW-5	SS-1	.5 - 5	ı	7.64	, CC [
GMW-7	55-1	3.5 - 5.0	ı	101.6	1.72.1
GMW-11	SS-1	- 5	!	101.9	1.621
GMW-15	55-1	3.5 - 5.0	I	9 • 98	9.76
\$ 6			1	93.8	110.0
mean standard deviation n	eviation		اسم <u>ا</u>	+7.1 -6	+12.4 6
=					

TABLE 7-3 (continued)

75 1 OF 25					
Borehole Sample	Depth Interval (ft)	Moisture Content	Centrifuge Moisture Equivalent	Effective Cation Exchange Capacity (meq/100g)	Distribution Ratio (ml/g)
G-18 G-21 G-21 GMW-1 GMW-3 GMW-4 GMW-5 GMW-7 GMW-7 GMW-11 GMW-11 GMW-11 GMW-11	3.5 - 5.0 3.5 - 5.0 3.5 - 5.0 3.5 - 5.0 3.5 - 5.0 3.5 - 5.0 3.5 - 5.0			1 1 1 1 1 1 1 1 1	1 1 t t 1 t t t
mean standard deviation n	L C	1 1 0	1 1 0	1 1 0	ı ı <b>C</b>

TABLE 7-3

(continued)

Page 5 of 25	£ 25							
					CALCULATE	CALCULATED PARAMETERS	S	
Borehole Number	Sample Number	Depth Interval (ft)	Void Ratio <sup>a</sup>	Porosity <sup>b</sup>	Specific Retention <sup>C</sup>	Specific Yieldd	Saturation <sup>e</sup>	Activity <sup>f</sup>
LOESS UNIT	11					٠		
G-18	-	3.5 - 5.0	ı	ţ	ı	<b>†</b>	3 1	; t
G-21	58-1	3.5 - 5.0	1	1	,	•	<b>!</b> !	•
GMW-1	SS-1	3.5 - 5.0	ı	ı	•	•	, ,	1
GMW-3	58-1	5.5 - 7.0	1	ı	•		, .	1
GMW-4	SS-1	3.5 - 5.0	i	ı	1	1	•	1
GMW-5	SS-1	3.5 - 5.0	1	ı	1	,	<b>r</b> 1	ı
GMW-7	58-1	3.5 - 5.0	1	1	1	ı	1 1	ı
GMW-11	SS-1 ·	3.5 - 5.0	ı	•	ı	1	<b>,</b> !	ı
GMW-15	SS-1	3.5 - 5.0	ı	1	1	1	l	
			ı	ı	I	1	ţ	ŀ
standard n	mean standard deviation n	uc	10	10	10	. 0	10	1 0

TABLE 7-3 (continued)

Pepth   Percentages of Grain Sizes   Number   Number   Number   (ft)   Gravel   Sand   Silt   Clay	Page 6 of	25					
ELVIEW FORMATION  1 3.5 - 5.0	Borehole Number	Sample Number	Depth Interval (ft)		1 1	Grain Silt	Clay
1 3.5 - 5.0 5 14 47 47 49  3 11.5 - 13.5 0 0 4 4 47 49  2 6.5 - 8.5 0 0 3 5 6 41  1 3.5 - 5.0	FERRELVIE	1	NOI		-		
1 3.5 - 5.0 5 14 47 49 39 11.5 - 13.5 0 4 47 49 49 6 6.5 - 8.5 0 7 4 47 49 49 6.5 - 8.5 0 7 4 49 6.9 1 1 3.5 - 5.0						!	ć
3 11.5 - 13.5 0 4 4 7 7 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	G-8	-	.5 - 5	5		/ 4	3.9 9.0
2 6.5 - 8.5 0 3 5.6 41 1 3.5 - 5.0	8-5	3	5 - 13	0		/ 5 1	4.7
1 3.5 - 5.0	6-5	5	.5 - 8	C		56	4 I
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	G-14	_	.5 - 5	1		•	ı
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	G-16	-	.5 - 5	1	i	1	1
3 $SS-2$ $8.5-10.0$ $0$ $16$ $26$ $26$ $28$ $3$ $3$ $ST-1$ $11.5-13.5$ $0$ $12$ $42$ $45$ $45$ $12$ $ST-1$ $11.5-13.5$ $0$ $12$ $14$ $45$ $43$ $45$ $13$ $11.5-13.5$ $10$ $14$ $48$ $45$ $13$ $11.5-13.5$ $10$ $14$ $11.5-13.5$ $11.5$ $11.5$ $11.5$ $11.5$ $11.5$ $11.5$ $11.5$ $11.5$ $11.5$ $11.5$	6-21	S	.5 - 10	1	ţ	1 1	1 C
3 ST-1 11.5 - 13.5 0 14 41 42 46 7 7 8T-1 11.5 - 13.5 0 12 46 13 13 13 13 14 44 15 11.5 - 13.5 0 14 46 15 16 16 16 16 16 16 16 16 16 16 16 16 16		- 1	.5 - 10	C	16	26	58 F
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	C-MMC	- 1	5 - 13	0	14	4.1	C <b>4</b>
12 ST-1 10.0 - 11.5	C-MWD	ST-1	5 - 13	0	12	4.2	0 6 6
13 ST-1 11.5 - 13.5	GMW-12	ST-1	0 - 11	10	14	707	1 <b>V</b>
15 ST-1 11.5 - 13.5	_	ST-1	5 - 13	C ;	- (	9 H	7 7
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	GMW-15	ST-1	5 - 13	Ď.	•0	33	r
SS-2 8.5 - $10.0$	GMW-17/					ı	1
SS-1 3.5 - 5.0 9 1/ SS-2 8.5 - 10.0	G-10	1	.5 - 10	1 (		1 0 7	
SS-2 $8.5 - 10.0$ $\frac{2.8}{10}$ $\frac{9.8}{10}$ $\frac{49.6}{10}$ $\frac{39.8}{10}$ $\frac{49.6}{10}$ $\frac{39.8}{10}$	_	- 1	.5 - 5	σ,		¥	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	GMW-18	1	5 - 10	ı	ı	1	İ
2.8 9.8 49.6 39. deviation $\begin{array}{cccccccccccccccccccccccccccccccccccc$							
deviation $\frac{+4.1}{10}$ $\frac{+5.5}{10}$ $\frac{+6.9}{10}$ $\frac{+10.}{10}$				2.8	•	9.	•
	mean standard	deviatio	د	+4.1 To	5.	90	•
	٦			0.7		· ·	

TABLE 7-3 (continued)

Borehole					
Number	Sample Number	Depth Interval (ft)	Liquid Limit	Plasticity Index	Unified Soil Classification
FERRELVIEW	EW FORMATION	Z			
	-	ı	1	, <b>I</b>	•
۵ م ا	٦ ~	- 13.	49	.33	JD.
0 0	, 0	6.5 - 8.5	40	. 23	CL
;-] <b>4</b>	ı ,—	5 - 5.	ı	<b>!</b>	ı
1-16		- 5.	t	ı	<b>!</b> ;
1-21	55-2	.5 - 10.	63	43	CH
MW-3	- 1	.5 - 10.	ı	1	1 ;
G-WMC	ST-1	.5 - 13.	55	41	<u>ت</u>
GMW-7	ST-1	.5 - 13.	55	37	
GMW-12	ST-1	.0 - 11.	50	32	トラーイン ・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・・
GMW-13	ST-1	.5 - 13.	45	28	ָרָרָי פַרָּי
_	ST-1	.5 - 13.	61	4 4	5
GMW-17/					!
G-10	SS-2	.5 - 1	1	1	I
GMW-18	55-1			í	I
GMW-18	SS-2	.5 - 1	1	i	1
			52.2	35.1	CL-CH
standard	standard deviation		+7.8	+7.5	ι ∞
_			æ	Þ	,

TABLE 7-3 (continued)

Page 8 of	25				
		Depth	Specific	Unit W	Weight
Borehole Number	Sample Number	Interval (ft)	Gravity (g/cm³)	0ry (1b/ft <sup>3</sup> )	Wet (1b/ft <sup>3</sup> )
FERRELVIEW	W FORMATION	NOI			
	-	•	ı	1	
۵ رو د ا	٦ (٢	-	10	115.1	127.3
o o - ''	o ~	6.5 - 8.5	2.63	103.5	•
ڻ−1 <b>4</b>		.5 -	₹	ľ	I
3-16	ı —	1	10	1	1
G-21	SS-2	.5 - 1	ľ	·	I
GMW-3	- 1	.5 - ]	2.56	1	
6 - MW.	ST-1	.5 - 1	2.62	101.7	
C-MM-7	ST-1	1	2.64	108.0	0.621
GMW-12	ST-1	1	2.59	73.3	•
_	ST-1	1	2.66	101.9	•
_	ST-1	1	2.67	8 · 8 h	•
GMW-17/				0 10	126 5
G-10	1	8.5 - 10.0	ı	101.9	•
GMW-18	- 1	.5 - 5		1	ı
GMW-18	SS-2	.5 - 10	2.67	1	ı
mean standard	deviation	u	2.61 +0.07 T1	101.3 +12.4 - 8	8 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 - 4 -
E			₹ -		-

TABLE 7-3 (continued)

Borehole	Sample	Depth Interval	Moisture	Centrifuge Moisture	Ettective Cation Exchange Capacity	Distribution Ratio
Number	Number	(ft)	Content	Equivalent	(meq/100g)	(m1/g)
FERRELVIEW	W FORMATION	<b>5</b> .1				
ر ع	_	.5 - 5.	ı	1	ì	,
8-U	1 m	11.5 - 13.5	24.5	41	t	ľ
6-5	2	6.5 - 8.	24.6	35	1	ľ
G-14	1	5 - 5.	1	,	1	1
G-16	-1	.5 - 5	ı	1	ı	ı
G-21	- 1	.5 - 1	ı	•	t	1
GMW-3	1.	5 - 10	1	1	ı	ı
GMW-3	ST-1	1.5 - 13	24.7	47	ı	1
GMW-7	ST-1	1.5 - 13	4.	46		
GMW-12	ST-1	0.0 - 11	5.	ı	60.2	47.9
_	ST-1	5 - 13	23.8	1	60.4	61.6
$\overline{}$	ST-1	1.5 - 13	4.	58	ı	ı
GMW-17/		•				
	ı	01 - 5.	1	I	ı	ı
GMW-18	55-1		1	ı	1	•
GMW-18	1	1.5 - 10	t	1		
mean standard	deviation		24.7	45.4 +8.5	60.3	54.8 +9.7
2				J.	2	7

TABLE 7-3 (continued)

page 10 of	£ 25					O COMPANA COMP		
					CALCULATE	CALCULATED PARAMETERS		
Borehole Number	Sample Number	Depth Interval (ft)	Void Ratio <sup>a</sup>	Porosity <sup>b</sup>	Specific Retention <sup>C</sup>	Specific Yield <sup>d</sup>	Saturation <sup>e</sup>	Activity <sup>£</sup>
FERRELVIEW FORMATION	W FORMAT	NOI				**-*.		
•	•		1	ı	1		ı	1
g-8	٦	0.0 - 0.0		91.0	238	<b>#</b>	100%	19.0
g-8	<b>~</b>	11.5 - 13.5	0.3/	2/7	\$ C C	e d	100	0.56
6-5	2	6.5 - 8.5	0.58	378	<b>\$</b> 87	96	<b>\$</b> 00 <b>1</b>	) • • I
G-14	1	3.5 - 5.0	1		1	t	ï	ı
6-16	-	3.5 - 5.0	ı	1	1	1	ı	ı <b>ı</b>
G-21	SS-2	8.5 - 10.0	ı	1	i	ı	1	ı <b>!</b>
GMW-3	SS-2	5 - 10.	1	1	1	1 4	, ,	
C-WWD	ST-1	11.5 - 13.5	0.29	228	38%	<b>*</b> 0	#00T	10.0
C-MM-7	ST-1	11.5 - 13.5	0.52	348	378	<b>\$</b>	2001	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0
GMW-12	ST-1	10.0 - 11.5	0.62	388	ı	ı	1004	C Y U
GMW-13	ST-1	11.5 - 13.5	0.63	398	1	1 6	\$00T	1 00
GMW-15	ST	11.5 - 13.5	69.0	418	468	<b>\$</b> 0	90.46	20.1
GMW-17/								1
G-10	SS-2	8.5 - 10.0	i	. 1	1	•	<b>1</b>	,
GMW-18	SS-1	3.5 - 5.0		t	•	•	<b>,</b> '	ı
GMW-18	SS-2	8.5 - 10.0	ı	ı	l	ţ	ı	
						?	9001	00.1
mean			0.53	348	368	8.7 V+	+1.4	+0.66
standard deviation	deviatic	uc	+0.15	<u>-  </u>	+	ր Մ -1	7-	7
			7	,	ſ	١		•

TABLE 7-3 (continued)

Page 11 or	6.7	4400				
	0	Depth	Pe	Percentages o	of Grain Sizes	
Borenole Number	Sample	(ft)	Gravel	Sand	silt	Clay
CLAY TILL	UNIT					
ı	į	o u	< 19	20	. 31	49
G-5	S.I1	0.0	+ C	; <del></del>		42
G-5	SS-3	15.	O	+ 1 >		ŧ
9-5		3.5 - 5.	1 -	י נ	,	45
9-9	m	5 - 13.	<b></b> 1 1	77	3 C	9 7
G-8	9	5 - 23.	C '	77	25	O 5
6-5	5	5 - 18.		77	30	
6-19	2	5 - 8.	<19		67	r C
G-20	2	0 - 8.	0	1.4	3.0	00
2-21	ST-1	8	C		31	
C.WW.	5.5	5 - 20.	ł	1	1 4	1 .
0 MM		5 - 13	0	22	<b>4</b> %	
VIME		5 - 20.	ũ	28	31	141
TI SMED		5 1 3	0	56	31	43
	- 1	5 - 13.	с	18	28	54
		7 70	_	25	34	41
CMW-/		.00	•	22	35	39
	1	.21 - 5.	<b>a</b> r C	ر د د	35	40
		.5 - 13.	o <b>c</b>	10	3 -	51
GMW-11		.5 - 15.		0.1	4 I	
		.5 - 20.	1 (		33	5.2
7	ST-1	.5 - 12	n	0.1	3 C	1 I
GMW-15	í	.5 - 30	1	t		
GMW-17/					1	ı
G-10	SS-4	18.5 - 20.0	i (	1 6	3.2	48
GMW-18	H	1.5 - 13.	0	0.7		
						i
			0.4	2.	31.7	45.6
mean	douist ion		,	+4.5	+2.4	+4.5
	neviario		- 8 		18	18
E			<b>&gt;</b>			

	_
.3	ed
7	nn
LE	بر. ند
AB	no
E	υ U
	_

Page 12 o	of 25				
Borehole Number	Sample	Depth Interval (ft)	Liquid Limit	Plasticity Index	Unified Soil Classification
	FINI			·	
	- 1				į
5-5	ST-1	.5 - 8.	53	36	H)
G-5	55-3	- 15.	1		I
9-9 8-9		13.5 - 5.0	1	1 6	¹ • C
9-5	e	.5 - 13.	46	67	ָּלָבָּ טִּלָבָּ
g-8	9	.5 - 23.	47	31	בייבין בייבין
6-9	5	.5 - 18.	50	3.4	
G-19	2	.5 - 8.	41	/ 7	ט ע
G-20	2	.8	62	43	ָּבָ <b>ָּ</b>
G-21	ST-1	.5 - 18.	42	67	ָבָּרָבָּרָבָּרָבְּרָבְּרָבְּרָבְּרָבְּר
GMW-3	SS-4	3.5 - 20.	81	33	ָּבָּי <b>:</b>
1	ST-1	1.5 - 13.	48		י נ
GMW-4	SS-4	.5 - 20.		1 6	΄ τ
GMW-5	ST-1	1.5 - 13.	44	67	
GMW-6	ST-1	1.5 - 13.	4.2	. 87	י פ
CMM-7	9-88	8.5 - 30.	T :		נ
GMW-8	ST-1	1.5 - 12.	44	æ r	ב נ
GMW-10	ST-1	1.5 - 13	39		ם מ נ
$\overline{}$	ST-1	3.5 - 15	58		: I
GMW-13	SS-4	8.5 - 20		1 6	נ
_	ST-1	1.5 - 12	53	<b>3.</b>	; ;
<b>–</b>	9-88	8.5 - 30	ì	1	1
7					1
6-10	1	8.5 - 20.		! (	ָ בּי
GMW-18	ST-1	11.5 - 13.5	52	39	
			50.3	34.2	CL
standard	deviation	<b>-</b>	+10.5	+8.4	71
			_16	16	0.7

TABLE 7-3 (continued)

fic Unit Unit 13)  (1b/ft3)  (1b/ft43)						
TILL UNIT  TILL UNIT  ST-1			Depth		Unit	Weight
TILL UNIT  ST-1 6.5 - 8.5 2.43 105.4 129.8  SS-3 13.5 - 15.0 2.67	Borehole Number	Sample Number	nterva (ft)	Gravity (g/cm³)	Dry (15/ft <sup>3</sup> )	wet 1b/ft
TILL UNIT  ST-1 6.5 - 8.5 2.43 105.4 129.3  SS-3 13.5 - 15.0					-	
ST-1 6.5 - 8.5 2.43 105.4 129.8  SS-3 13.5 - 15.0	1	1				
SS-3 13.5 - 15.0	G-5		.5 - 8.	•	Ŋ	29.
1 3.5 - 5.0 2.67 10.6 136. 3 11.5 - 13.5 2.65 110.6 135. 5 6.5 - 8.5 2.61 100.9 127. 2 6.5 - 8.5 2.68 107.9 127. 2 6.5 - 8.5 2.69 107.9 127. 3 SS-4 18.5 - 20.0 - 2.64	G-5		.5 - 15.	t	1	•
3 11.5 - 13.5 2.65 110.6 136. 5 6 21.5 - 23.5 2.61 103.9 121. 2 6.5 - 8.5 2.68 107.3 125. 2 6.5 - 8.5 2.68 107.9 125. 3 ST-1 16.5 - 18.5 2.64	9-5 3-8		.5 - 5.		1	ı
6 21.5 - 23.5 2.61 103.9 121. 2 6 6.5 - 8.5 2.60 107.3 127. 2 6.0 - 8.0 2.67 96.7 121. 2 5 6.0 - 8.0 2.67 96.7 122. 3 5S-4 18.5 - 20.0	9-5	m	.5 - 13.	9.	10.	36.
5 16.5 - 18.5 2.60 107.3 127. 2 6.5 - 8.5 2.68 107.9 125. 2 6.0 - 8.0 2.67 96.7 121. 2 8.7-1 16.5 - 18.5 2.64	8-B	9	1.5 - 23.	9.	03.	21.
2 6.5 - 8.5 2.68 107.9 125. 2 5.0 - 8.0 2.67 96.7 121. 2 5.0 - 8.0 2.67 96.7 121. 3 5S-4 18.5 - 20.0 - 2.46 102.9 122. 4 5S-4 18.5 - 20.0 - 2.62 113.4 132. 5 5T-1 11.5 - 13.5 2.66 104.7 121. 6 5T-1 11.5 - 13.5 2.66 104.7 121. 8 5T-1 11.5 - 12.5 2.66 104.7 121. 11 5T-1 13.5 - 15.5 2.68 98.2 113.4 117. 11 5T-1 13.5 - 12.5 2.68 98.2 123. 12 5S-4 18.5 - 20.0 2.68 98.2 123. 13 5S-4 18.5 - 20.0 2.68 98.2 105.5 107.5 112. 14 5T-1 11.5 - 13.5 2.68 98.2 105.5 112. 18 5T-1 11.5 - 13.5 2.62	6-5	5	.5 - 18.	9.	07.	27.
2 6.0 - 8.0 2.67 96.7 121.85 2.64	G-19	7	.5 - 8.	9.	07.	25.
ST-1 16.5 - 18.5	G-20	2	.0 - 8.	9.	9	21.
SS-4 18.5 - 20.0 - 6 102.9 122.  4 ST-1 11.5 - 13.5 2.62 113.4 132.  5 ST-1 11.5 - 13.5 2.65 104.7 121.  5 ST-1 11.5 - 13.5 2.66 104.7 121.  7 SS-6 28.5 - 30.0 - 7 100.3 113.  10 ST-1 11.5 - 12.5 2.55 105.5 105.5 113.  11 ST-1 11.5 - 12.5 2.68 - 98.2 121.  12 SS-4 18.5 - 20.0 2.68 - 98.2 121.  13 SS-4 18.5 - 20.0 2.68 - 98.2 121.  14 ST-1 11.5 - 13.5 2.55 105.2 105.2 112.  18 ST-1 11.5 - 13.5 2.60 104.8 123.  19 dard deviation	G-21	ST-1	.5 - 18.	9.	ı	1
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	GMW-3	SS-4	.5 - 20.	ı	ı	ı
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	GMW-4	ST-1	.5 - 13.	7.	02.	22.
ST-1 11.5 - 13.5	GMW-4	SS-4	8.5 - 20.	1		1
ST-1 11.5 - 13.5	GMW-5	ST-1	1.5 - 13.	9.	13.	32.
SS-6 28.5 - 30.0 - 11.5 - 12.5 2.37 100.3 113.   ST-1 11.5 - 12.5 2.37 100.3 113.   ST-1 11.5 - 12.5 2.55 106.5 105.5 129.   3 SS-4 18.5 - 20.0 2.68 98.2   SS-6 28.5 - 30.0 2.68    8 ST-1 11.5 - 13.5 2.55 105.2   112.	GMW-6	ST-1	1.5 - 13.	9.	04.	21.
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	GMW-7		8.5 - 30.	ı		
0 ST-1 11.5 - 13.5 - 15.5 104.6 117.   11 ST-1 13.5 - 15.5 2.55 105.5 1129.   3 SS-4 18.5 - 20.0 2.68	GMW-8	ST-1	1.5 - 12.	٠,	•	13.
11 ST-1 13.5 - 15.5 2.55 105.5 129.   13 SS-4 18.5 - 20.0 2.68   14 ST-1 11.5 - 12.5 2.68 98.2 121.   15 SS-6 28.5 - 30.0 2.68   17 SS-4 18.5 - 20.0 2.62   18 ST-1 11.5 - 13.5 2.55 105.2 112.   112.    2.60	GMW-10	ST-1	1.5 - 13.		•	17.
13 SS-4 18.5 - 20.0 2.68 98.2 121. 14 ST-1 11.5 - 12.5 2.68 98.2 121. 15 SS-6 28.5 - 30.0 2.68	_	ST-1	3.5 - 15.	S	•	29.
14 ST-1 11.5 - 12.5 2.68 98.2 121.  15 SS-6 28.5 - 30.0 2.68	_	- 1	8.5 - 20.	9		1
15 SS-6 28.5 - 30.0 2.68	_	- 1	1.5 - 12.	9	œ	21.
$\frac{17}{8}$ SS-4 $\frac{18.5}{5}$ - 20.0 $\frac{2.62}{2.55}$ $\frac{-}{105.2}$ $\frac{-}{112}$ . $\frac{-}{11}$ $\frac{-}{11$	_	- 1	8.5 - 30.	9	t	i
SS-4 $18.5 - 20.0$ $2.62$ $-13.5$ $112.$ 18 ST-1 $11.5 - 13.5$ $2.55$ $105.2$ $112.$ dard deviation $+0.09$ $+4.4$ $+7.$ $-14.0$ $-$	GMW-17/					
-18 ST-1 11.5 - 13.5 2.55 105.2 112.	G-10	S	8.5 - 20.	9.	1	1
deviation $\begin{array}{cccccccccccccccccccccccccccccccccccc$	7	Ħ	1.5 - 13.	.5	05.	12.
deviation $\begin{array}{cccccccccccccccccccccccccccccccccccc$						
deviation $\begin{array}{cccccccccccccccccccccccccccccccccccc$				,	70	~
	mean standard		<b>E</b>	· 0	+4.	
	ם בחומה ב		-	ά α		14

TABLE 7-3 (continued)

Page 14 of 25					
Borehole Sample Number Number	Depth Interval (ft)	Moisture Content	Centrifuge Moisture Equivalent	Effective Cation Exchange Capacity (meq/100g)	Distribution Ratio (m1/g)
CLAY TILL UNIT					
G-5	.5	22.9	34	1	ı
G-5 SS-3	.5 - 15.			1	t
3-6	.5 - 5.	ł		•	1
	11.5 - 13.5	18.0	9	•	ı
9 8-0	.5 - 23.	•	33	ı	ı
	.5 - 18.	18.7	45	ı	ı
	.5 - 8.	÷	37	ı	ı
	0 - 8.	23.5	46	1	1
	.5 - 18	•	ı	8.09	38.6
~	.5 - 20.	ı	1	ı	ı
4	5 - 13.	19.7	41	•	i
•	.5 - 20.	ſ	•	1	i
	.5 - 13.	18.7	34	ı	ı
٠,	.5 - 13.		34	•	ı
	.5 - 30.			ı	ı
<b>~</b>	.5 - 12.	5.	51	1	ı
0	.5 - 13.	17.2	40	1	ı
11	3.5 - 15.	Э·		1	ı
13	.5 - 20.	ı		1	t
14 ST-	1.5 - 12.	23.3	45	ı	t
GMW-15 SS-6	.5 - 30.	ı	I	ı	1
17/					1
1	.5 - 20	ı	I	, t	
GMW-18 ST-1	1.5 - 13.	21.7	1	77.3	6.67
					34.2
standard deviation n	ion	+3.0 T5	+3·/	2 5	. ~

TABLE 7-3 (continued)

Page 15 of	£ 25							
					CALCULATED	CALCULATED PARAMETERS		
Borehole Number	Sample Number	Depth Interval (ft)	void Ratio <sup>a</sup>	Porosity <sup>b</sup>	Specific Retention <sup>C</sup>	Specific Yieldd	Saturation <sup>e</sup>	Activityf
CLAY TILL	TILL UNIT							•
G-5	ST-1	6.5 - 8.5	0.44	30%	278	<b>&amp;</b> E	1008	0.73
S-5	55-3	13.5 - 15.0	1	i	ı	•	ı	ŧ
9-5	-	3.5 - 5.0	ı	1	1	•	•	1 (
9-5	· m	11.5 - 13.5	0.50	338	298	48	95.48	0.64
2-8 2-8	9	21.5 - 23.5	0.57	368	268	108	778	0.67
6-5	ις.	16.5 - 18.5	0.51	348	368	<b>8</b> 0	95.38	0.69
G-19	~	ı	0.55	358	308	28	82.38	0.61
G-20	7	6.0 - 8.0	0.72	428	378	58	87.18	0.86
G-21	ST-1	16.5 - 18.5	ı	ı	ı	1	i	0.69
C.W.	55-4	18.5 - 20.0	ı	1	•	ı	1	1 1
GMW-4	ST-1	11.5 - 13.5	0.49	33%	32.8%	0.28	96.86	67.0
GMW-4	SS-4	.5 20.	•	1	1	1	1 6	1 4
GMW-5	ST-1	11.5 - 13.5	0.44	30%	278	# M	100%	0.6
GMW-6	ST-1	11.5 - 13.5	0.58	378	278	10%	85.38	76.0
GMW-7	9-SS	28.5 - 30.0	ı	ı	1	•	1 6	, ,
GMW-8	ST-1	11.5 - 12.5	0.47	328	418	<b>*</b> 0	/9.18	7/*0
GMW-10	ST-1	11.5 - 13.5	ı	1	328		1 6	96.0
GMW-11	· ST-1	13.5 - 15.5	0.51	348	338	<b>#</b>	\$001	00.0
GMW-13	SS-4	18.5 - 20.0	i	ſ	1	1 1	1 6	י כ ע
GMW-14	ST-1	11.5 - 12.5	0.70	418	368	<b>\$</b>	87.68	•
GMW-15	9-88	28.5 - 30.0	ı	i	ı	ť	t	ı
GMW-17/	٠							
G-10	SS-4	18.5 - 20.0	1	1	1	1	1 6	6
GMW-18	ST-1	11.5 - 13.5	0.51	348	1	ı	1004	10.0
				•				
5			0.54	358	328	48	91.58	0.70
med II	0:40::00	1	60 01	+3.6	+4.7	+3.5	+ 8.6	-0.10
standard	standard deviation =	<b>-</b>	13		13	12	13	15
=			7					

TABLE 7-3 (continued)

ø		•					
	9[011	Depth Interval	Pe	Percentages of Grain Sizes	Grain Sizes		1
na Tagilina	Number	(ft)	Gravel	Sand	Silt	Clay	
BASAL TILL UNIT	TINI						
1 2		33 5 - 35 0	c	œ	56	36	
G-13 /	2 C - 2	<b>ار</b>	: <b>C</b>	9	63	31	
-	ST-1	1.5 - 1	39	26	10	25	
	37-1	<u>-</u>	25	4.1	16	18	
CMW-5	SS-5	- 2	ı	1 4	1 G	ן ה	
	8S-9	43.5 - 45.0	0	9 !	ور د ر	C 7	
	ST-1	11.5 - 13.5	C	25	cs.	<b>4</b>	
теап			10.7	18.7	39.8	30.8	
standard deviation	viation	<b>C</b>	$\frac{+17.1}{6}$	$\frac{+14.3}{-6}$	0.52 <del>+</del> - 6	1.0+1 9+1	

TABLE 7-3 (continued)

Page 17 of 25	£ 25				
Borehole Number	Sample Number	Depth Interval (ft)	Liquid Limit	plasticity Index	Unified Soil Classification
BASAL TILL UNIT	L UNIT				
G-15 G-21 GMW-1 GMW-2 GMW-5 GMW-7	7 SS-5 ST-1 SS-5 SS-9 ST-1	33.5 - 35.0 23.5 - 24.2 11.5 - 13.5 11.5 - 12.5 23.5 - 25.0 43.5 - 45.0	35 66 35 31 41	19 43 16 14 26	- 12 26 26 26 27 27
mean standard n	deviation		41.6 +14.1 - 5	23.6 +11.7	GC-CL -

TABLE 7-3 (continued)

Page 18 of 25	25				
		Denth	Specific	Unit Weight	
Borehole S Number N	Sample Number	Interval (ft)	Gravity (g/cm³)	Dry (1b/ft <sup>3</sup> )	Wet (1b/ft <sup>3</sup> )
BASAL TILL UNIT	UNIT				
G-15	7	•	ı	104.8	126.5
G-21	SS-5	.5 - 2	1	99.4	114.1
_	ST-1	11.5 - 13.5	2.45	86.5	6./01
<b>~</b> 1	ST-1	.5 - 1	1.	t :	1
	55-5	.5 - 2	I	) () ()	8 201
	88-9	.5 - 45	,	103.6	117 9
GMW-9	ST-1	11.5 - 13.5	I	104.8	7.1.1.
mean		S	1 1	99.8	118.6
Standalu deviation n	1 a c 1 o	-	1	5	ις

TABLE 7-3 (continued)

Dade 19 of 25					
	Depth Interval (ft)	Moisture Content	Centrifuge Moisture Equivalent	Effective Cation Exchange Capacity (meq/1009)	Distribution Ratio (ml/g)
			7		
BASAL TILL UNIT				e e	
7 7	33.5 - 35.0	ı	•	ŧ	ı
5-21		•		•	l
	11.5 - 13.5	23.0	40	1 6	<b>.</b> 900
GMW-2 ST-1	11.5 - 12.5	23.1	i	79.0	007
ı rv	23.5 - 25.0	ł	•	1	ı ı
7	43.5 - 45.0	ı	1 1	ı	ı
6	11.5 - 13.5	16.5	37	I	ı
mean standard deviation		20.9 +3.8 -3	38.5 +2.1 2	1 1 7	
=					

TABLE 7-3

(continued)

Page 20 of 25	£ 25							
					CALCULATED	CALCULATED PARAMETERS		
Borehole Number	Sample Number	Depth Interval (ft)	Void Ratio <sup>a</sup>	Porosity <sup>b</sup>	Specific . Retention <sup>C</sup>	Specific Yield <sup>d</sup>	Saturation <sup>e</sup>	Activityf
BASAL TILL UNIT	L UNIT							
G-15	7	33.5 - 35.0	ı	1	1	1	1	1
6-21	5.5	23.5 - 24.2	•	1	1	ı	1	0.61
GMW-1	ST-1	11.5 - 13.5	0.77	448	328	88	73.28	1.72
GMW-2	ST-1	11.5 - 12.5	ı	ı	1	ı	i	68.0
GMW-5	SS-5	23.5 - 25.0	ı	ı	ı	1	1	t
GMW-7	88-9	43.5 - 45.0	ı	r	1	1	1	1 (
GMW-9	ST-1	11.5 - 13.5	i	1	308	1	l	0.65
mean	,		ı	ı	318	ı	1	0.97
standard deviation n	deviatio	r.			-1 <sub>2</sub>			+0.52 -4

TABLE 7-3 (continued)

	clay	13
	Percentages of Grain Sizes Sand Silt	19
	rcentages of Sand	48
	Per	20
	Depth Interval (ft)	3.5 - 5.0
£ 25	Sample Number	SS-1
Page 21 of 25	Borehole Number	FILL GMW-8

TABLE 7-3 (continued)

Page 22 of 25	f 25				
Borehole Number	Sample Number	Depth Interval (ft)	Liquid Limit	Plasticity Index	Unified Soil Classification
FILL GMW-8	SS-1	3.5 - 5.0	1	<b>I</b>	SM
			•		

TABLE 7-3 (continued)

ple Interval Gravity (1b/ft3)  ber (ft) (g/cm³) (1b/ft3)  -1 3.5 - 5.0 2.54		Page 23 OI 25				
Sample       Interval       Gravity       Dry         Number       (ft)       (g/cm³)       (lb/ft³)         SS-1       3.5 - 5.0       2.54       -			Depth	Specific	Unit W	leight
3 SS-1 3.5 - 5.0 2.54	Borehole S Number N	ample	Interval (ft)	Gravity (g/cm³)	Dry (1b/ft <sup>3</sup> )	Wet (1b/ft <sup>3</sup> )
3 SS-1 3.5 - 5.0 2.54 -	0.11.1					
SS-1 3.5 - 5.0 2.54 -	1100					
		55-1		2.54	: <b>1</b>	
					-	

TABLE 7-3 (continued)

Page 24 of 25	£ 25					
Borehole Number	Sample Number	Depth Interval (ft)	Moisture Content	Centrifuge Moisture Equivalent	Effective Cation Exchange Capacity (meq/1909)	Distribution Ratio (m1/g)
FILL GMW-8	SS-1	3.5 - 5.0	I	1	!	1

TABLE 7-3

(continued)

Page 25 of 25

		d t			CALCULATED	CALCULATED PARAMETERS		
Borehole Number	Sample Number	Interval (ft)	Void Ratio <sup>a</sup>	Porosity <sup>b</sup>	Specific Retention <sup>C</sup>	Specific Yield <sup>d</sup>	Saturation <sup>e</sup> Activity <sup>f</sup>	Activityf
FILL						·		
GMW-8	SS-1	3.5 - 5.0	ı	1	t .	•	1	ţ

avoid Ratio = (specific gravity x unit weight of water/dry unit weight) - 1bporosity = (void ratio/1 + void ratio) x 100%

NOTES:

Specific Retention = centrifuge moisture equivalent x 0.80 (Ref. 26)  $^{e}$ Saturation = (specific gravity x moisture content)/void ratio dSpecific Yield = porosity - specific retention

 $f_{Activity}$  = plasticity index/percent of clay 91 percent used for mean and standard deviation determinations

#### 8.0 SITE HYDROGEOLOGY

The site hydrogeological investigation included delineation of the uppermost aquifer, installation of groundwater monitoring wells, determination of groundwater movement including direction, gradient, and velocity, and evaluation of site hydrogeochemistry.

#### 8.1 AQUIFERS

The uppermost aquifer at the site is the upper fractured and weathered zone in the Burlington/Keokuk Formation. A saturated zone in the residuum unit was also noted in boreholes G-19 and GMW-15, but since this zone appeared to be localized in these areas, the residuum was not considered in the hydrogeological investigation of the site.

To characterize the permeability of the uppermost aquifer, borehole field permeability tests were performed during the drilling These tests included constant head (packer) tests as described by the U.S. Bureau of Reclamation (Ref. 27) and variable head tests as described by Hvorslev (Ref. 28). Packer testing equipment was calibration tested to develop a head loss curve for the equipment, with supplemental head loss curves taken from the U.S. Bureau of Reclamation (Ref. 29). Results of the field permeability tests are presented on Table 8-1. Test results are also presented on the hydrogeological cross sections (Figures 7-2 through 7-4) to allow evaluation of lateral and vertical variations in permeability. Permeability tests were conducted in four specific zones as shown on the table. The upper two zones represent the vadose zone in the bedrock, the third zone is the uppermost aquifer, and the fourth zone represents the unweathered bedrock underlying the aquifer. Permeability testing at the overburden/bedrock interface was limited due to difficulties in maintaining a seal around the outside of the hollow stem augers. Permeability tests were attempted in this zone in all but the first four boreholes (G-1 through G-4) drilled during this investigation. Leakage of water

around the outside of the augers occurred in all tests except for Tests in both the unsaturated and those presented in Table 8-1. saturated zones in the bedrock indicate variations in permeability of up to four orders of magnitude. These variations in permeability may-result from variations in the interconnection of solution features and/or variations in solution feature filling materials or degree of filling. Comparison of permeability measurements in the weathered and unweathered portions of the bedrock indicate that average permeabilities in the fresh rock section are three orders of magnitude lower than in the weathered bedrock. The results of the permeability testing program indicate that the aquifer is of variable permeability in the horizontal plane and generally becomes less permeable with depth due to decreased weathering and associated solution activity.

# 8.2 MONITORING WELL INSTALLATIONS

Assessment of the site hydrogeological conditions requires groundwater monitoring wells to allow acquisition of groundwater level and groundwater quality data.

An electromagnetic terrain conductivity (EM) survey was performed prior to finalizing groundwater monitoring well locations. The EM survey data can be used to detect changes in conductivity in the subsurface, such as would be created by a conductive plume of contaminated groundwater. The results of the EM survey are presented in Appendix E. The EM survey data indicated that an anomalous high conductivity area was present in the eastern portion of the site. A groundwater monitoring well (GMW-17) was relocated from its original design location to investigate this anomaly.

A system of 17 groundwater monitoring wells was designed to monitor groundwater quality. The wells were designed with type 316L schedule 40 stainless steel casing and screen for durability and chemical stability. The wells are designated with a GMW prefix to differentiate them from previously installed wells of

polyvinylchloride construction. As-built well construction details are presented in Appendix F, and locations are shown on Figure 7-1. Table 8-2 presents a summary of the monitoring well installation data, including those wells installed during the previous BNI (Ref. 12) investigation.

Boreholes were reamed to 8-1/2-in. diameter using an air rotary tricone roller bit drilling system prior to well installation. All drilling equipment, casing, and screens were steam cleaned prior to each well installation to preclude downhole contamination or cross-contamination between boreholes. Water used for well installation and development activities was obtained from the St. Charles County water supply system. Following well installation, all monitoring wells were developed by air lift pumping and flushing with water to remove the maximum practical amount of fine-grained materials from the well.

### 8.3 GROUNDWATER MOVEMENT

Investigation of groundwater movement involved measurement of groundwater levels in the uppermost aquifer. Table 8-3 presents the results of two groundwater level measurement surveys. These two surveys were taken to represent two seasons of the hydrological year. The measurements taken at the end of July represent the low recharge season when precipitation is minimal and evapotranspiration is maximal in an average year. The measurements taken in November represent an increased recharge period due to a reduction in evapotranspiration (Ref. 30). These measurement sets were contoured to generate the potentiometric surface maps shown on Figures 8-1 and 8-2. These maps represent an interpretation of spatially and temporally limited data. Additional monitoring points and groundwater level measurements will allow further refinement of the potentiometric contours.

# 8.3.1 Groundwater Flow Direction

Examination of the potentiometric surface maps (Figures 8-1 and 8-2) indicates that a groundwater divide passes through the eastern portion of the site, beneath the surface water divide (Section 6.0). Groundwater to the east of this divide flows east-southeast toward the Missouri River. Groundwater to the west of the divide flows north-northwest toward the Mississippi River.

# 8.3.2 Hydraulic Gradient

Hydraulic gradients can be qualitatively evaluated by examination of the spacing of the equipotential lines on the potentiometric surface maps. Closely spaced equipotential lines indicate a steep hydraulic gradient, and widely spaced lines indicate a shallow hydraulic gradient. Variations in spacing of equipotential lines within an aquifer may indicate a change in aquifer permeability. This phenomenon relates to Darcy's Law which states that groundwater flow is equal to the permeability times the hydraulic gradient times the cross sectional area of flow. To maintain steady-state flow, when the permeability decreases, the hydraulic gradient must increase, since the cross sectional area is assumed to be a constant. This phenomenon can be observed on the two potentiometric surface maps, in the area of GMW-6 (frog pond area). Permeability values (Table 8-1) for GMW-6, GMW-8, and GMW-13 are two to three orders of magnitude below the average permeability for the aquifer.

Quantitative measurements of hydraulic gradients in the central and western portions of the site range from 0.02 to 0.03. The hydraulic gradient in the area of GMW-6 is approximately 0.05.

# 8.3.3 Groundwater Velocity

The average interstitial velocity of groundwater can be approximated by a modified form of Darcy's Law (Ref. 31):

$$V = \frac{Ki}{\alpha}$$

where

V = groundwater velocity (L/T)

K = permeability (L/T)

i = hydraulic gradient (dimensionless)

 $\alpha$  = porosity

Using the average aguifer permeability 1.6 x  $10^{-3}$  cm/s (4.5 ft/day), a hydraulic gradient of 0.025, and an average porosity for limestone of 0.30 (Ref. 31), the resulting average interstitial velocity is 0.4 ft/day. In the area of GMW-6, using a permeability of 8.9 x  $10^{-5}$  cm/s (0.25 ft/day), a hydraulic gradient of 0.05, and an average porosity for limestone of 0.30 (Ref. 31), the average interstitial velocity is  $0.04 \, \text{ft/day}$ . It should be noted that the groundwater gradients and velocities discussed herein assume conditions of Darcian flow. The fractured nature of the aquifer indicates, at least locally, that the constraints for Darcian flow are not met and conduit flow is occurring. The intent of the discussion of hydraulic gradients and interstitial velocities is to provide preliminary macroscale characteristics of the aquifer. To fully evaluate the effects of the non-Darcian flow would require utilization of tracer studies and other techniques to characterize localized groundwater flow.

# 8.4 HYDROGEOCHEMISTRY

A total of 27 groundwater and raffinate pit water samples were taken in September and October of 1986. Thirteen of these samples were submitted for chemical and radiological analyses. An additional 10 samples were scheduled for chemical analyses but, due to a DOE stop work order, could not be submitted for analysis prior to

expiration of the storage period for the analytical parameters. Four additional samples were submitted only for radiological analysis. Chemical analyses were performed by Envirodyne Engineers of St. Louis, Missouri, and radiological analyses were performed by Envirodyne Engineers and Thermo Analytical (TMA)/Eberline.

Analytical results are presented in Appendix G and summarized on Table 8-4.

The results of the major ion chemical analyses were plotted on a trilinear diagram (Figure 8-3) using the method described by Piper (Ref. 32). Examination of the trilinear diagram indicates the following:

- o Up-gradient (Wells B-11 and B-23) groundwater chemistry is significantly different from raffinate pit (RP-1, RP-2, and RP-3) water chemistry on all three fields of the diagram.
- o Several down-gradient wells (GMW-2A, GMW-3, B-19A, and GMW-5) exhibit water chemistry similar to the raffinate pit water chemistry.
- o The distribution of the groundwater chemistry data suggests a mixing relationship with the up-gradient water chemistry (Wells B-11 and B-23) as one end member and an unidentified water chemistry as the other end member.

Evaluation of the analytical results indicates that two of the raffinate pit samples (RP-1 and RP-3) and four of the groundwater samples (Wells B-19A, GMW-2A, GMW-3, and GMW-5) have anion-cation imbalances. The analyses show 20 to 60 percent more cations than anions. The imbalance in the raffinate pit samples appears to be related to the presence of a two-phase system (solid and liquid) in the pits. Equilibrium reactions between the solid and liquid phases proceed at different rates due to variations in chemical solubilities and are frequently disrupted by direct and run-on input of fresh water from precipitation events. The cause of the imbalance in the groundwater samples is not as straightforward. Typically, three causes can be associated with an ionic imbalance. First, failure to analyze for a major constituent may create an apparent imbalance. Since the ionic imbalance indicates a paucity

of anions, this would suggest that one or more additional anionic substances may be present. Generally, other anionic substances found in groundwater include orthophosphate, sulfite, tetraborate, and halogens such as iodide and bromide. A second possible explanation for the imbalance involves disruption of equilibrium during and/or after sampling. This disruption can be caused by a variety of mechanisms including biological activity, pressure release (e.g., outgassing of carbon dioxide), or precipitation reactions. A third possible cause involves analytical error which may stem from a variety of causes including interference between ions. For example, sulfite interferes with the determination of chloride, and heavy metals interfere with the determination of sulfate concentrations. One or more of these three causes may have created the observed anionic imbalance.

Selected trace constituents, including lithium, molybdenum, vanadium, total uranium, and radium-226, were also measured from the samples. All of these trace constituents are present in one or more of the raffinate pits in significant concentrations. Groundwater analyses showed the following results:

- O Lithium. The highest concentration was observed at Well GMW-3, with detectable concentrations also occurring in Wells B-19A, GMW-2A, and GMW-5.
- o Molybdenum. Molybdenum concentrations were not quantified in any groundwater samples.
- o Vanadium. The highest vanadium concentration was observed in Well GMW-4, with detectable concentrations also occurring in Wells B-19A and GMW-3.
- o Total uranium. The highest total uranium concentration was observed in Well B-4, with elevated concentrations observed in Wells B-2 and B-21.
- o Radium-226. The highest radium-226 concentration was observed at Well GMW-18, with elevated concentrations at Wells GMW-1, GMW-10, GMW-13, and GMW-14.

The lithium and vanadium concentrations observed in the groundwater are thought to be derived from the area around the ash pond. Visual observations and the results of the EM survey (Appendix E) indicate that metallic and other debris, both buried and on the surface, are present in the ash pond area. Leaching of these materials may contribute to the elevated levels of trace metals. Boring and trench data for the area northwest of the dike indicate that the residuum layer is 10 to 12 ft below the surface. As discussed in Section 6.0, the ash pond is constructed in a topographic depression. Thus, the base of the ash pond is at or near the top of the residuum. Runoff from the disposal area would transport degrading materials into the ash pond, which could then infiltrate the bedrock aguifer.

The presence of the elevated total uranium concentration in Well B-4 approximately coincides with the high conductivity anomaly This may also correlate identified in the EM survey (Section 8.2). with the elevated radium-226 concentration at Well GMW-18. implication of this interpretation is that contamination is migrating to those sites from an up-gradient infiltration source. Since the southeastern end of the site is topographically slightly higher than the adjacent Missouri Conservation Department/Weldon Spring Wildlife Area properties, a possible mechanism to explain this source is suggested. However, more recent groundwater samples collected from Well B-4 have shown background uranium concentrations. Thus, it appears that a longer period for collection of water quality data for this well is needed to understand whether the test results indicate a cyclic condition or a one-time anomalous reading. At Well GMW-18, the uranium and radium in the water must have entered by some route other than vertical infiltration from the ground surface through the clayey overburden, because those clays have a strong affinity for both radium and uranium (Ref. 25). A deep burial area or a presently unknown thin overburden area up-gradient of Well GMW-18 is a likely entry location for the uranium found in the water there. After water level measurements have been made for at least a full year's

cycle in that well, the groundwater contours and the up-gradient direction(s) from Well GMW-18 can be refined. Using this information, a search for areas with thin bedrock cover up-gradient of the well can be conducted.

A cement-bond log for Wells B-4 and GMW-18 might indicate that the seal that isolates the well screen from the overburden has deteriorated, so low quality water could enter the well along the annulus.

The elevated radium-226 levels in Wells GMW-10, GMW-13, and GMW-14 appear to be related to the frog pond. The frog pond receives runoff from the northeastern portion of the site. Well GMW-6, located adjacent to the frog pond, indicates that the overburden thickness is approximately 23 ft in this area; however, the frog pond is topographically lower than the well and thus, the overburden beneath the frog pond is less. Seepage may enter the bedrock aquifer beneath the frog pond or in the swampy area downstream from the frog pond. Since the frog pond is located across the groundwater divide as presented on Figures 8-1 and 8-2, the area to which infiltrating water is contributed is also on either side of that divide. However, because the overburden thickness is variable, the water contributed to the groundwater system on one side of the divide may have a quality different from the water on the other side.

Permeabilities measured in Well GMW-6 ranged from  $10^{-5}$  to  $10^{-6}$  cm/s, indicating a set of conditions differing from that of Well GMW-10 in which a permeability of  $10^{-3}$  cm/s was measured. This may explain the absence of radium-226 in Well GMW-6. Similarly, Well GMW-1, located to the west of the ash pond, is in an area of thin overburden cover, and thus may be receiving contaminants from the ash pond area.

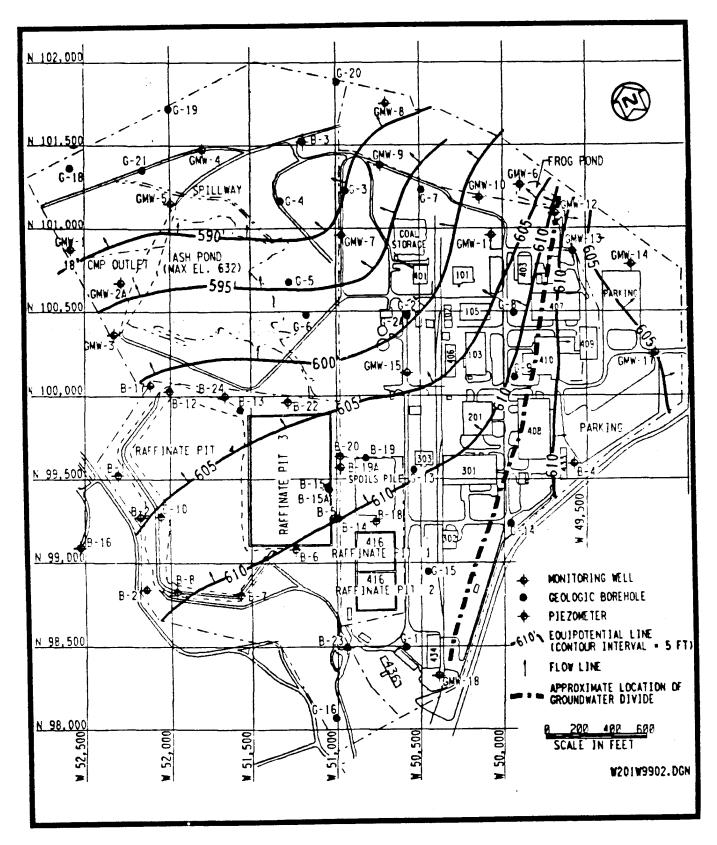


FIGURE 8-1 GROUNDWATER CONTOURS, JULY - AUGUST 1986

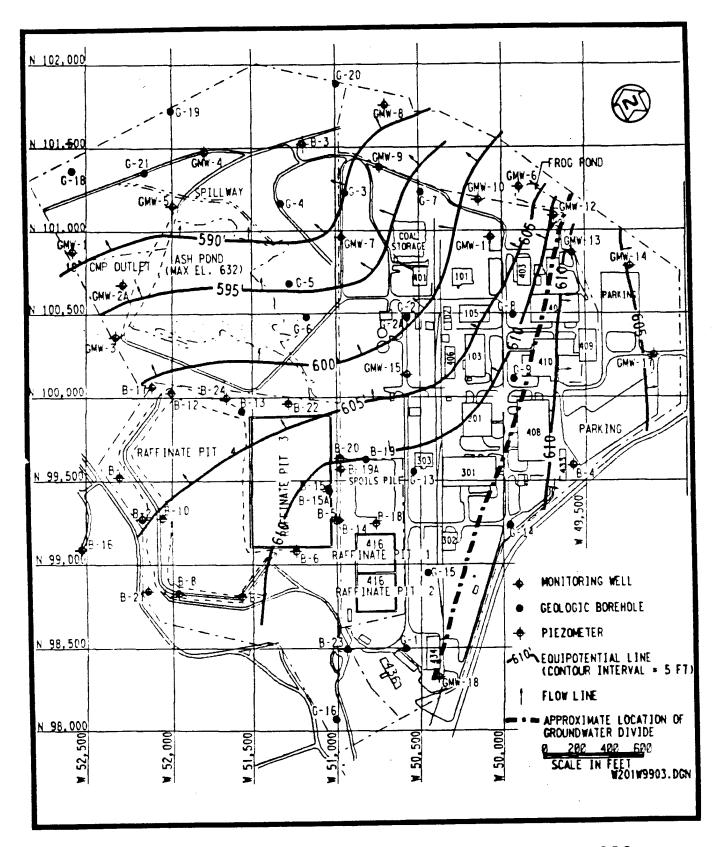


FIGURE 8-2 GROUNDWATER CONTOURS, NOVEMBER 1986

FIGURE 8-3 PIPER TRILINEAR DIAGRAM

TABLE 8-1
PERMEABILITY TEST DATA

Borehole Number	Test Number	Depth Interval (ft)	Permeability (cm/s)	Test Type <sup>a</sup>
Overburden/	Bedrock Int	erface		
G-8	2	30.0 - 32.6	$4.7 \times 10^{-3}$	CHDP
G-9	1	36.0 - 37.5	$9.2 \times 10^{-2}$	CHSP
G-16	1	29.0 - 34.0	$1.5 \times 10^{-4}$	FH
		38.0 - 41.5	$6.3 \times 10^{-2}$	CHSP

Statistics<sup>b</sup>: n = 4mean = 3.7 x  $10^{-2}$ standard deviation = 4.3 x  $10^{-2}$ variance = 1.9 x  $10^{-3}$ 

# Unsaturated, Weathered, and Fractured Bedrock

G-3	1	56.0 - 66.7	$1.4 \times 10^{-3}$	CHDP
G-7	1	26.9 - 32.8	$2.2 \times 10^{-3}$	CHDP
G-8	1	31.7 - 37.6	$5.4 \times 10^{-3}$	CHDP
G-18	1	35.6 - 41.6	$8.5 \times 10^{-3}$	CHDP
G-20	1	40.0 - 46.0	$1.9 \times 10^{-3}$	CHDP
GMW- 3	2	30.0 - 36.0	$3.4 \times 10^{-4}$	CHDP
GMW-5	ı	38.8 - 44.7	$2.2 \times 10^{-3}$	CHDP
GMW-9	1	23.0 - 29.0	$3.6 \times 10^{-3}$	CHDP
GMW-17	ı	25.6 - 31.6	$4.7 \times 10^{-3}$	CHDP
GMW-18	2	30.0 - 36.0	$6.8 \times 10^{-6}$	CHDP

Statistics<sup>b</sup>: n = 10mean = 2.7 x  $10^{-3}$ standard deviation = 2.0 x  $10^{-3}$ variance = 4.0 x  $10^{-6}$ 

TABLE 8-1 (continued)

Borehole	Test	Depth Interval	Permeability	Test
Number	Number	(ft)	(cm/s)	Typea
Saturated,	Weathered,	and Fractured B	<u>edrock</u>	
			•	
G-1	1	54.0 - 64.7	$1.0 \times 10^{-3}$	CHDP
G-1	2	64.0 - 74.7	$2.8 \times 10^{-4}$	CHDP
G-2A	1	56.5 - 67.2	$3.5 \times 10^{-4}$	CHDP
G-2A	2	67.0 - 77.7	1.2 x 10 <sup>-4</sup>	CHDP
G-4	1	55.8 - 66.5	1.1 x 10 <sup>-3</sup>	CHDP
G-5	1	45.3 - 51.3	$<6.4 \times 10^{-7}$	CHDP
G-5	2	55.3 - 61.3	$1.3 \times 10^{-6}$	CHDF
G-13	1	30.1 - 36.0	$5.0 \times 10^{-3}$	CHDF
G-15	1	51.0 - 56.3	$2.4 \times 10^{-4}$	CHDF
G-16	2	45.0 - 50.3	$6.1 \times 10^{-3}$	CHDF
G-19	2	41.0 - 47.0	$8.0 \times 10^{-3}$	CHDF
<b>G-2</b> 0	2	43.0 - 49.0	$6.9 \times 10^{-4}$	CHDF
GMW-1	ı	29.0 - 35.0	$<9.5 \times 10^{-7}$	CHDF
GMW- 2A	2	35.2 - 41.2	$2.1 \times 10^{-4}$	CHDF
GMW- 3	1	44.0 - 50.0	$< 8.0 \times 10^{-7}$	CHDF
GMW-4	1	52.0 - 58.0	$<9.3 \times 10^{-7}$	CHDE
GMW-4	2	53.6 - 72.0	$<3.9 \times 10^{-7}$	CHSI
GMW- 6	1	41.8 - 47.7	$8.9 \times 10^{-5}$	CHDE
GMW- 6	2	32.8 - 38.7	$2.6 \times 10^{-6}$	CHD
GMW-8	1	45.0 - 51.0	$3.9 \times 10^{-5}$	CHD
GMW-8	2	35.0 - 41.0	$3.7 \times 10^{-5}$	CHD
GMW-10	1	40.0 - 46.0	$2.1 \times 10^{-3}$	CHDI
GMW-11	1	53.5 - 59.5	-c-	CHD
GMW-13	1	40.0 - 46.0	$5.9 \times 10^{-6}$	CHDI
GMW-14	ı	44.0 - 50.0	$2.8 \times 10^{-4}$	CHDI
GMW-15	1	50.3 - 56.2	$9.1 \times 10^{-3}$	CHD

TABLE 8-1 (continued)

Page 3 of 4				
Borehole Number	Test Number	Depth Interval (ft)	Permeability (cm/s)	Test Type <sup>a</sup>
GMW-15 GMW-18	1	62.3 - 68.2 42.0 - 48.0	5.2 x 10 <sup>-5</sup> 8.9 x 10 <sup>-5</sup>	CHDP

# Statisticsb:

n = 22

mean =  $1.6 \times 10^{-3}$ 

standard deviation =  $2.8 \times 10^{-3}$ 

variance =  $7.8 \times 10^{-6}$ 

# Slightly Weathered to Fresh Bedrock

			6	CUCD
G-9	2	66.0 - 76.0	$3.6 \times 10^{-6}$	CHSP
G-14	1	64.0 - 76.4	$<3.5 \times 10^{-7}$	CHSP
G-19	3	51.0 - 57.0	$<7.8 \times 10^{-7}$	CHDP
G-21	1	58.5 - 74.5	$2.1 \times 10^{-6}$	CHSP
GMW- 2A	1	51.8 - 57.8	$<6.8 \times 10^{-7}$	CHDP
GMW-7	1	62.0 - 68.0	8.2 x 10 <sup>-7</sup>	CHDP
GMW-12	1	52.0 - 58.0	$1.7 \times 10^{-5}$	CHDP
GMW-13	2	62.0 - 68.0	$5.2 \times 10^{-6}$	CHDP

# Statisticsb:

n = 5

mean =  $5.7 \times 10^{-6}$ 

standard deviation =  $6.5 \times 10^{-6}$  variance =  $4.2 \times 10^{-11}$ 

#### aTest Type:

CHDP = Constant Head Double Packer Pressure Test

CHSP = Constant Head Single Packer Pressure Test

FH = Falling Head Test

# TABLE 8-1 (continued)

## Page 4 of 4

# bStatistics:

n = number of samples used for evaluation (tests with values reported as less than (<) were not included in the statistical evaluation

CThe high water take on this test resulted in a head loss greater than the total head for the test and thus the test is considered invalid.

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TABLE 8-2 MONITORING WELL SUMMARY

Page 1 of	2				
Well Number	Reference Elevation	Depth of Well (ft)	Monitoring Interval <sup>a</sup> (ft)	Well Completionb	Monitoring Zone
B-2	633.08	26.8	18.8 - 25.8	2-in. PVC screen	Clayey silt/glacial till
B-3	637.08	150.5	62.7 - 145.6	2-in. PVC screen	Burlington/Keokuk formation
B-4	657.00	119.6	36.5 - 119.6	3-in. Open hole	Burlington/Keokuk formation
B-9	635.38	84.7	41.0 - 84.7	3-in. Open hole	Burlington/Reokuk formation
B-11	671.78	106.2	51.0 - 106.2	3-in. Open Hole	Burlington/Keokuk formation
B-14	655.62	21.8	13.7 - 21.1	2-in. PVC screen	Silty clay/glacial till
B-15A	99.599	32.0	24.25 - 32.0	2-in. PVC screen	Silty clay/glacial till
B-16	623.06	28.5	20.5 - 26.5	2-in. PVC screen	Residuum
B-17	646.44	99.1	39.0 - 99.1	3-in. Open hole	Burlington/Keokuk formation
B-19A	648.18	101.0	39.0 - 101.0	3-in. Open hole	Burlington/Keokuk formation
B-21	646.52	99.4	45.0 - 99.4	3-in. Open hole	Burlington/Keokuk formation
B-23	667.01	7.06	52.5 - 90.7	3-in. Open hole	Burlington/Keokuk formation
B-24	652.14	23.5	20.0 - 23.0	2-in. PVC screen	Glacial till
GMW-1	614.10	59.0	31.6 - 58.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-2A	626.00	59.0	31.7 - 58.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-3	638.80	59.0	41.5 - 58.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-4	644.80	76.5	54.3 - 75.5	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-5	637.70	76.5	50.0 - 75.5	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-6	635.80	66.5	27.0 - 65.5	2-in. Stainless steel screen	Burlington/Reokuk formation
CMW-7	651.00	94.0	62.3 - 93.0	2-in. Stainless steel screen	Burlington/Reokuk formation
GMW-8	621.90	56.5	34.0 - 55.5	2-in. Stainless steel screen	Burlington/Reckuk formation
GMW-9	639.10	58.6	27.2 - 57.6	2-in. Stainless steel screen	Burlington/Reokuk formation
GMW-10	644.10	59.0	37.2 - 58.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-11	655.20	73.8	36.6 - 72.8	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-12	638.20	59.0	29.3 - 58.0	2-in. Stainless steel screen	Burlington/Reokuk formation
GMW-13	647.40	69.0	31.3 - 68.0	2-in. Stainless steel screen	Burlington/Keokuk formation
GMW-14	649.40	59.0	37.0 - 58.0	2-in. Stainless steel screen	Burlington/Reokuk formation
GMW-15	659.90	78.5	47.3 - 77.5	2-in. Stainless steel screen	Burlington/Keokuk formation

TABLE 8-2

(continued)

Page 2 of 2

Monitoring Zone	Burlington/Reokuk formation Burlington/Reokuk formation
Well Completion <sup>b</sup>	30.0 - 63.0 2-in. stainless steel screen 37.4 - 63.0 2-in. stainless steel screen
Monitoring Interval <sup>a</sup> (ft)	30.0 - 63.0
Depth of Well (ft)	64.0
Reference Elevation	669.90
Well Number	GMW-17 GMW-18

Amonitoring Interval: For wells with screens, the monitoring interval is defined by the depth to the bottom of the bentonite seal and the depth to the bottom of the screen. For wells with open hole completion, the monitoring interval is defined as the depth of the bottom of the surface casing and the depth of the bottom of the well.

# bwell completion:

2-in, PVC screen - diameter polyvinylchloride riser pipe, #40 slot screen, and sump with filter pack and bentonite seal.

- 4-in.-diameter polyvinylchloride surface casing cemented into the bedrock with 3-in.-diameter 3-in. open hole .open hole below. 2-in. stainless steel screen = 2-in.-diameter type 3166 stainless steel riser pipe, #10 slot screen, and 1-ft sump, with filter pack and bentonite seal.

TABLE 8-3
GROUNDWATER ELEVATIONS

Well Number	07/24-30/86	11/01/86
GMW-1	588.86	589.15
GMW-2A	593.71	594.13
GMW-3	597.98	597.92
GMW-4	584.56	583.97
GMW-5	588.26	588.23
GMW-6	601.54	601.85
GMW-7	590.36	590.26
GMW-8	585.98	585.91
GMW-9	597.96	597.81
GMW-10	600.46	600.85
GMW-11	600.72	600.80
GMW-12	610.43	612.12
GMW-13	605.26	607.98
GMW-14	604.45	604.25
GMW-15	603.99	603.54
GMW-17	605.51	604.85
GMW-18	615.43	614.80
B-3	580.41	574.49
B-4	607.92	607.60
B-17	599.61	600.42
B-19A	608.70	610.84
B-21	607.77	607.22
B-23	612.84	612.23

TABLE 8-4
HYDROGEOCHEMICAL DATA

Monitoring Point Parameter <sup>a</sup>	Raffinate Pit 1	Raffinate Pit 2	Raffinate Pit 3	Well B-2	Well B-4
Calcium (mg/l)	361	101	420	102	ND
Magnesium (mg/l)	19.2	46.9	311	53.9	ND
Sodium (mg/l)	420	78	767	19.4	ND
Potassium (mg/l)	38	20	105.95	1.24	ND
Lithium (mg/l)	BQL	BQL	2.79	BQL	ND
Molybdenum (mg/l)	3.34	6.67	3.96	BQL	<b>N</b> D
Strontium (mg/l)	1.04	0.353	1.76	0.212	ND
Vanadium (mg/l)	2.38	1.41	0.548	BQL	<b>N</b> D
Total Uranium (ppb)	41	130	130	26	28
Radium-226 (pCi/l)	57 <u>+</u> 6	40 ± 4	120 <u>+</u> 10	0.6 <u>+</u> 0.1	BQ
Carbonate (mg/l)	BQL	BQL	BQL	BQL	ND
Bicarbonate (mg/l)	50.8	39	50	128.6	<b>N</b> D
Sulfate (mg/l)	<b>31</b> 5	796	495	26	ND
Chloride (mg/l)	27.2	6.2	36.3	4	ND
Nitrate (mg/l)	404	10.13	1170	88.8	ND
Nitrite (mg/l)	1.78	0.55	2.69	BQL	<b>N</b> D
Hardness (mg/l as CaCO <sub>q</sub> )	936	470	2461	493	ND
Conductivity (µmhos/cm)	3515.8	425.5	9449.5	977.1	ND
рН	8.01	8.63	8.06	7.90	ND
ORP (mv)	300	278	354	298	ND
Gross Alpha (pCi/l)	190 <u>+</u> 40	590 ± 50	230 <u>+</u> 50	11 <u>+</u> 6	16 <u>+</u>
Gross Beta (pCi/l)	91 <u>+</u> 12	250 <u>+</u> 20	410 ± 30	9 <u>+</u> 7	0 <u>+</u>

TABLE 8-4
(Continued)

Monitoring Point Parameter <sup>8</sup>	Well B-11	Well B-17	Well B-19A	Well B-21	Well B-23
Calcium (mg/l)	61.9	<b>N</b> D	951	ND	47
Magnesium (mg/l)	34.5	ND	250	ND	53.1
Sodium (mg/l)	11	ND	284	ND	26.3
Potassium (mg/l)	1.18	ND	3.54	ND	17.54
Lithium (mg/l)	BQL	ND	0.22	<b>N</b> D	BQL
Molybdenum (mg/l)	BQL	ND	BQL	ND	BQL
Strontium (mg/l)	0.103	ND	2.57	ND	0.210
Vanadium (mg/l)	BQL	ND	0.064	ND	BQL
Total Uranium (ppb)	BQL	7	5	26	ND
Radium-226 (pCi/l)	0.3 ± 0.1	0.6 ± 0.1	0.2 <u>+</u> 0.1	BQL	ND
Carbonate (mg/l)	BQL	ND	BQL	ND	BQL
Bicarbonate (mg/l)	260.4	ND	251.6	ND	<b>3</b> 65
Sulfate (mg/l)	38	ND	57	ND	13
Chloride (mg/l)	6.8	ND	22.1	ND	1.7
Nitrate (mg/l)	1.5	<b>N</b> D	870	ND	1.10
Nitrite (mg/l)	BQL	ND	0.06	ND	BQL
Hardness (mg/l as CaCO <sub>3</sub> )	286	<b>N</b> D	3448	ND	340
Conductivity (µmhos/cm)	450.0	ND	7368.4	ND	7352.8
рН	8.11	7.10	7.17	ND	8.18
ORP (mv)	268	ND	336	ND	300
Gross Alpha (pCi/l)	15 ± 5	BQL	BQL	9 ± 4	ND
Gross Beta (pCi/l)	22 <u>+</u> 6	76 <u>+</u> 9	BQL	12 <u>+</u> 3	ND

TABLE 8-4 (Continued)

Monitoring Point Parameter <sup>8</sup>	Well GMW-1	Well GMW-2A	Well GMW-3	Well GHW-4	Well GMW-5
					100
Calcium (mg/l)	ND	210	235	59.2	182
Magnesium (mg/l)	ND	5.45	84.6	39.6	. 49
Sodium (mg/l)	ND	70.2	57.2	14.4	71.5
Potassium (mg/l)	ND	17.54	10.54	1.76	9.96
Lithium (mg/l)	ND	0.21	0.45	BQL	0.27
Molybdenum (mg/l)	ND	BQL	BQL	BQL	BQL
Strontium (mg/l)	ND	0.610	0.723	0.305	0.722
Vanadium (mg/l)	ND	BQL	0.025	0.084	BQL
Total Uranium (ppb)	11	BQL	BQL	BQL	BQL
Radium-226 (pCi/l)	$3.5 \pm 0.8$	$0.3 \pm 0.1$	$0.5 \pm 0.1$	$0.3 \pm 0.1$	$0.5 \pm 0.7$
Carbonate (mg/l)	ND	BQL	BQL	BQL	BQL
Bicarbonate (mg/l)	<b>N</b> D	49.8	237.8	<b>3</b> 50	83.2
Sulfate (mg/l)	ND	64	210	13	76
Chloride (mg/l)	ND	7.9	13	4	9.6
Nitrate (mg/l)	ND	167	236	1.20	185
Nitrite (mg/l)	ND	0.82	BQL	BQL	BQL
Hardness (mg/l as CaCO <sub>3</sub> )	ND	547	962	320	656
Conductivity (µmhos/cm)	ND	1601.6	2551.4	619.9	1794.7
рН	<b>N</b> D	7.35	7.81	7.81	7.64
ORP (mv)	ND	<b>33</b> 3	308	229	321
Gross Alpha (pCi/l)	25 <u>+</u> 9	BQL	BQL	BQL	BQL
Gross Beta (pCi/l)	18 <u>+</u> 4	26 <u>+</u> 77	20 <u>+</u> 8	BQL	21 <u>+</u> 8

TABLE 8-4 (Continued)

Page 4 of 5  Monitoring Point  Parameter <sup>8</sup>	Well GMW-6	Well GMW-7	Well GMW-8	Well GMW-9	Well GHW-10	Well GMW-11
Calcium (mg/l)	<b>N</b> D	ND	83.1	ND	ND	61.3
Magnesium (mg/l)	ND	ND	33.1	ND	ND	30.7
Sodium (mg/1)	ND	ND	18.0	ND	ND	10.4
Potassium (mg/l)	ND	ND	3.13	ND	ND	3.76
Lithium (mg/l)	ND	ND	BQL	ND	ND	BQL
Molybdenum (mg/l)	ND	ND	BQL	ND	MD	BQL
Strontium (mg/1)	<b>N</b> D	ND	0.246	ND	ND	0.116
Vanadium (mg/1)	ND	ND	BQL	ND	ND	BQL
Total Uranium (ppb)	4	11	BQL	6	7	ND
Radium-226 (pCi/1)	BQL	BQL	BQL	BQL	3.3 <u>+</u> 0.6	ND
	ND	ND	BQL	ND	ND	BQL
Carbonate (mg/l)	ND	ND	271	ND	ND	295
Bicarbonate (mg/l)	ND ND	ND	59	ND	ND	12
Sulfate (mg/1)	ND ND	ND	50.4	ND	ND	2.8
Chloride (mg/l)	ND ND	ND	BQL	ND	ND	4.13
Nitrate (mg/1) Nitrite (mg/1)	ND ND	ND	BQL	ND	ND	BQL
Hardness (mg/l as CaCO <sub>3</sub> )	<b>N</b> D	ND	356	<b>N</b> D	ND .	438
Conductivity (umhos/cm)	<b>N</b> D	ND	6837.0	ND	ND	5597.
рН	ND	ND	7.76	ND	ND	7.90
ORP (mv)	ND	ND	298	ND	ND	297
Gross Alpha (pCi/l)	BQL	14 <u>+</u> 8	BQL	6 <u>+</u> 5	12 <u>+</u> 7	ND
Gross Beta (pCi/l)	13 ± 3	15 ± 3	17 ± 7	5 ± 3	8 <u>+</u> 3	ND

TABLE 8-4 (Continued)

Monitoring Point Parameter <sup>a</sup>	Well GMW-12	Well GMW-13	Well GMW-14	Well GHW-15	Well GMW-18
Calcium (mg/l)	ND	<b>N</b> D	ND	ND	ND
Magnesium (mg/l)	ND	ND	ND	ND	ND
Sodium (mg/l)	ND	ND	ND	, MD	ND
Potassium (mg/l)	ND	ND	ND	ND	ND
Lithium (mg/l)	ND	ND	ND	ND	ND
Molybdenum (mg/l)	ND	ND	ND	ND	ND
Strontium (mg/l)	ND	NĎ	ND	ND	ND
Vanadium (mg/l)	ND	ND	ND	ND	ND
Total Uranium (ppb)	3	9	9	8	11
Radium-226 (pCi/l)	BQL	2.0 <u>+</u> 0.6	2.2 + 0.8	BQL	5.3 ± 0.9
Carbonate (mg/l)	ND	ND	ND	ND	ND
Bicarbonate (mg/l)	ND	ND	ND	<b>N</b> D	ND
Sulfate (mg/l)	ND	ND	ND	ND	ND
Chloride (mg/l)	ND	ND	ND	<b>N</b> D	ND
Nitrate (mg/l)	ND	ND	ND	ND	ND
Nitrite (mg/l)	ND	ND	ND	<b>N</b> D	ND
Hardness (mg/l as CaCO <sub>3</sub> )	ND	ND	<b>й</b> D	ND	ND
Conductivity (µmhos/cm)	ND	ND	<b>N</b> D	<b>N</b> D	ND
рН	ND	<b>N</b> D	ND	ND	<b>N</b> D
ORP (mv)	ND	ND	ND	ND	ND
Gross Alpha (pCi/l)	BQL	10 <u>+</u> 7	10 <u>+</u> 5	BQL	19 <u>+</u> 9
Gross Beta (pCi/l)	BQL	8 <u>+</u> 3	6 <u>+</u> 3	4 ± 3	23 <u>+</u> 4

BQL = Below Method Quantitation Limit
ND = Not Determined

**b**Oxidation-Reduction Potential or Redox

#### 9.0 FINDINGS

To synthesize the results of this investigation, the following subsections address the objectives of the investigation as outlined in Section 2.1.

# 9.1 GROUNDWATER MONITORING SYSTEM

Groundwater monitoring at the site appears to be complicated by the presence of a groundwater divide which creates two distinct down-gradient directions. Monitoring wells were installed to monitor both down-gradient directions. Results of preliminary groundwater sampling and analysis indicate that surface runoff is likely to be the primary transport agent for degrading materials, with infiltration of runoff to the groundwater system as a secondary mechanism.

#### 9.2 WASTE CONTAINMENT DESIGN

Evaluation of geological data from the site indicates several favorable features for waste containment design:

- o Areas of thick overburden deposits are present.
- o The clay till and Ferrelview Formation exhibit good sorbtive characteristics for radionuclides.
- o Based upon the raffinate pit and ash pond dike performance, the native soils are stable when used to construct engineered, slopes.
- o Bedrock coring indicates the absence of large solution cavities which might affect the stability of a waste containment structure.

Evaluation of the hydrogeological information also suggests that the groundwater system is restricted to the upper portion of the bedrock and, in some cases, the residuum layer. Thus, the unsaturated zone, in the areas of the thickest overburden, ranges from 30 to 50 ft in thickness.

The geological and hydrogeological data also indicate several unfavorable features for waste containment design:

- Areas of the site where the overburden is thin have the basal till and/or residuum units exposed, both of which may have poorer sorptive characteristics.
- o The uppermost aquifer is composed of fractured and solutioned limestone which would provide a pathway for transport of contaminants off-site, if these contaminants were to reach the bedrock.
- o The fractured nature of the aguifer adds additional complexity to the design of a permanent groundwater monitoring system with respect to locating the wells in the interconnected fractures which form the aguifer.
- o The presence of a groundwater divide at the site would require installation of a larger number of permanent groundwater monitoring wells to allow monitoring of both down-gradient directions.

The data collected in this investigation does not preclude the use of this site as a long-term storage facility. However, detailed investigations of the selected waste containment area and longer term monitoring of hydrogeochemistry and groundwater levels are recommended prior to final site selection.

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APPENDIX A
BORING LOGS



		FOI	OGIC	DRII	L L	OG	P	o.er			MELDON S	SPRING SITE	14501		9627	#A # 3	IRALE IRA. G-1
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	334		Peen 51-6			1	mı				ADJACENT	TO BUILDING 43	15			MALE M	G-1



	G	EO	LOGI	C DI	RILI	LC	)G	ROJECT	FUSF	RAP	- NELDON SPRING SITE 14501-201 2	NO. SIGLE NO. or 3 G-1
AND DIAMETER	SMPLER ADVANCE LENGTH CORE HUR	SAMPLE RECOVERY	SAPPLE REOVS "N" PERCENT COPE	L055 114 C.P.R.	MATER MESSUR TESTS	TIME IN MINUTES	ELEVATION	C DEPTH	BANHIC LOS	SAMPLE	BESCRIPTION AND CLASSIFICATION	NOTES ON! WATER LEVELS, WATER RETURN, OMMACTER OF ORBILLING, ETC.
2.	18*	18*	24	157 6*	11	13	633.0	35		7		BOREHOLE WAS RA- DIOLOGICALLY LOGGED BY EBER- LINE ANALYTICAL CORPORATION PRIOR
\$\$ \$*	18"	11*	76	27	34	42	628.3	39. 7- 40 -		8	39.7-45.3 FT LIMESTONE, VERY LIGHT GRAY (N8), VERY SOFT, DECOMPOSED, DRY, CONTAINS CLASTS OF LESS MEATHERED LIMESTONE.	TO CORING.  BURLINGTON/KEOKUI FORMATION.
72	10"	7.	50+	20	50/4				H	9		SAMPLER REFLISAL.
NO CORE		5.0					<b>622.</b> 7	45 45.3-   50		RUN ®1	45.3-79.5 FT LIMESTONE, LIGHT GRAY (N7) TO DARK YELLDVISH ORANGE (10YR 6/6), SOFT TO HARD, HIGHLY TO MODER- ATELY WEATHERED, VUGGY, IRON STAINED, VUGS RANGE IN SIZE FROM 4CM TO LESS THAN D.5CM. UPPER 2 FT OF CORE CON- TAIN HEALED FRACTURES ORIENTED FROM 0-20° RELATIVE TO CORE AXIS. REMAIN- DER OF UNIT CONTAINS HORIZONTAL FRAC- TURES, ROUGH PLANAR APERATURE, IRON STAINED, SOME CONTAIN CLAY FILLING.	45.3-84.0 FT DRILLED WITH NO DIAMOND CORE BAR- REL LISING WATER  RUN *1  ROD * 66X LP * 0.8 FT AP * 0.5 FT  1/30/86
NO CORE	10.0	3.6	96%	17.0 17.5 18.5 19	i	9 4 6 6		55 -		RUN +2	FRACTURE SPACING VARIES FROM 0.1-0.5	RUN #2  ROD = 66X  LP = 0.8 FT  AP = 0.3 FT
NO CORE	I C. O	9.8	<b>98</b> 2	1.5	22 29	4 15		65 <b>-</b>		RGN •3		RUN #3 ROD = 55X LP = 0.8 FT AP = 0.3 FT
							593.0	75		1	·	HOLE NO.
			SPOON; 5'				SITE				ADJACENT TO BUILDING 435	G-1



	벙크		OGI	I	WATER		DG I	ROJECT	FUS	RAF	- WELDON SPRING SITE J4501-201 3	NO. NOLE NO. G-1
AND DIAMETER	SAPTER ADVA	SAPPLE RECOVERY	ARCONENA COME AND A SENCE AND A SENCE SECOND STREET	1065 JN G.P.M.	TESTS  1:5.4	T) WE TO THE TOTAL	ELEVATION 593. 0	75	BUATHIC LOG	SAMIE	DESCRIPTION AND CLASSIFICATION	MOTES ON! MATER LEVELS, MATER RETURN, DIARACTER OF DRILLING, ETC.
NO CORE	1 D. Q	10.0	100x					79.5- 80 -		FUN OF	79.5-84.0 FT LINESTONE, MEDIUM LIGHT GRAY (N6), HARD, MASSIVE, STYLOLITIC, CORE BREAKS ALONG STYLOLITES, THIN (0.2 FT) CHERT LAYERS.	RUN +4 ROD + 75X AP + 0.4 FT LP + 1.5 FT
											BOTTOM OF BORING AT 84.0 FT. BORING GROUTED TO SURFACE ON 1/31/86.	ROD-ROCK QUALITY DESIGNATION FOR EACH RUN. AP-AVERAGE LENGTH OF CORE PIECES LP-LONGEST PIECE OF CORE FROM EACH RUN.  ALL SOIL AND ROCH COLOR DESCRIP- TIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCI- ETY OF AMERICA.
			POOR; 51-			5	ITE				ADJACENT TO BUILDING 435	HDLE NO.



	G	EOL	OGIC	DRI	LL	.0G		NO.EC		WP	-	WELDON SF	RING SITE	1450	1-201		<b>#</b> 2	G-7
Τ£		-	OF BUIL				COCADANATES				-	49. 3	<b>¥50,577.</b> 3		MOLE	90	)	SEASOG .
/23	/86	1	PLETED 2/6/86	SMLL		TONY TOXE E	CALTRY NGINEERII	- 1	DPALL			-55 ATV	5 1/4°				71.5 21.5	SALO FT
	SCORE OF	1/52	730	CORE	2	34441	3 0_10	<u> </u>		•		57.9	PTIVEL COMM	MATER MEASURED		MEPT N	AL TO 6	FT/65.4
	-	DE	DO PALL	_1	-		III IIILLI BAL/	LBSTH		_		USSES 57:		LAURENCE	Wine			
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	$\vdash$	L		<u> </u>	<u> </u>	<del> </del>	622.9	35		Ш	L		DED GRAVEL				ļ	
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SAPPLE TYPE	Davide allians	SAMPLE RECOMENT	MECONELL TOTAL	1065 14 6.P.R.	WATER WESTS WATER	TIME IN THE MINGRES	ELEVATION	NE SEPTH	<b>801</b> 3( <b>108</b>	SHOPLE	BESCRIPTION AND CLASSIFICATION	MATES CON- WATER LEVELS, WATER RETURN, BARBACTER OF BRILLING, ETC.
\$\$ \$\$				יש וצו	20 (	30 T	<b>622.9 622.4</b>	35. <del>5</del>		1	THE TA A PT CUIT AND COANE! MOREDATE	BOREHOLE WAS
	11*		50+	19	50/5*	/	615.9	38			BROWN (SYR 3/4), STIFF, NOIST, SILT AND ANGLEAR CHERT GRAVEL.  38.0-42.5 FT CLAYEY SILT, NEGERATE BROWN (SYR 3/4), VERY STIFF, NOIST,	RADIOLOGICALLY LOGGED BY EBER- LINE ANALYTICAL COMPORATION PRIOR TO CORING.
ಜ್_	18.	23'	21	,	10	11		" :		L	TRACE TO SOME ANGULAR CHERT BRAVEL.	:
								42.5		1	42.5-44.8 FT LINESTONE, WERY LIGHT GRAY (NO.), SOFT, EXTREMELY WEATHERED, CHERT FRAMERITS.	BURLINGTON/KEOKUK FORMATION. 44.8 FT SAMPLER MEFUSAL.
<b>S</b> S:	3.	4'	50+	50/3°	•		612.9	45	F	i	44.8-64.0 FT LINESTONE, DARK YELLOWISH	ROD = 0 X
MO CORE	1.0	0.4	40					:	莊		ORANGE (10YR 6/6) TO VERY LIGHT GRAY (N8), MEDIUM SOFT TO MARD, HIGHLY	AP - 0.05 FT
NO COPE	7.0	0.9	13					50 -		MM •2	WEATHERED, MUGGY, 0.5 TO 0.8 FT CHERT LAYERS, HORIZONTALLY FRACTURED, SMOOTH PLAMAR SURFACE, IRON STAINING ON FRAC- TURE MARGINS, FRACTURES FILLED WITH	P = 0.2 FT  REM =2  RED = 0.2  AP = 0.05 FT  LP = 0.2 FT
										- -	SILT AND CLAY.	RUM +3 RCD = 36X AP = 0.2 FT UP = 0.5 FT
NO CORE	5.0	3.2	64					55 -		2		REN #4 RCD = 25X AP = 0.1 FT LP = 0.6 FT
NO CORE	6.0	5.4	90					50 -		* 5	60.0-64.0 FT STYLOLITES.	44.0-64.0 FT DRILLED WITH NO DIMOND CORE DRILL WITH WATER.
2							553.9	ч			BOTTOM OF BORING AT 64.8 FT. BORING ABANDONED AND REPLACED BY BORING G-2A.	ROD-ROCK QUALITY BESIGNATION FOR EACH RUM. AP-AVERAGE LENGTH
											BORING EMOUTED TO SUFFACE ON 2/6/86.	OF CORE PIECES LP-LONGEST PIECE OF CORE FROM EACH RUN.
									*			ALL SOIL AND ROCK COLOR DESCRIP- TIONS FROM THE BOCK COLOR CHART PRINTED BY THE SEGLOSICAL SOCI-
-			SPOON; 51 NJ P-PIT				NTR.	<u> </u>	<u> </u>	<u></u>	EAST OF BUILDING 428	ETY OF MERICA.



GEOLOGIC DRILL LOG FUSRAP - WELDON SPRING SITE 14501-  SITE  EAST OF BUILDING 428 N100, 440.0 W50, 578.1  MEGIN COMPLETED DRILLER TONY CALTRY DRL: MAKE AND MODEL HELE SOX OVERBLEREN C 2/4/86 2/6/86 BROTCKE ENGINEERING CME-55 ATV 6 1/4*/3" 45.0  COPY RECOVERYOFILED COPE BOXES SAMPLES CL. TOP OF CASSIC SPOUND EL. BEPTIVEL BROAD BATER PRESSURE TESTS  SAMPLE MAMBER MEDITIFALL CASSIC LEFT OF MOLE DAL/LENGTH MONE  LAWRENCE Y  BATER PRESSURE TESTS  BESCRIPTION AND CLASSIFICATION  BESCRIPTION AND CLASSIFICATION  BESCRIPTION AND CLASSIFICATION  BESCRIPTION AND CLASSIFICATION	MIGLE FROM HORIZ.  90 FTJ ROCK FTJ TOTAL DEPTH  38.0 83.0 FT  BEPTRIZEL TOP OF ROCK  45.0 FT/663.0
EAST OF BUILDING 428  N100,440.0 W50,578.1  NCELN COMPLETED DIBLER TONY CALTRY DIRL MAKE AND MODEL POLY SOX OVERBLINGER OF CALTRY CALTRY CALTRY CALTRY BROJOXE ENGINEERING CALTS ATV 6 1/4°/3° 45.0  COMPLETED DIRLER TONY CALTRY DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRLER TONY CALTRY DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRLER TONY CALTRY DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRLER TONY CALTRY DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRLER TONY CALTRY DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRL MAKE AND MODEL POLY 30 AS.O  COMPLETED DIRL MAKE AND MODEL	90 - FTJ ROCK FTJ TOTAL DEPTH  38.0 83.0 FT  BEPTINELL TOP OF ROCK  45.0 FT/653.0  FOUNG  BETTES CON- BETTER LEVELS, BATER RETURN.
BEGIN DOMPLETED DRELER TONY CALTRY DRL: MAKE AND MODEL HOLE SOX OVERBLABELY OF 2/4/86 2/6/86 BROTCKE ENGINEERING CME-55 ATV 6 1/4°/3" 45.0 COME RECOVERYFULL COME BOXES SAMPLES DL. TOP OF CASONC ROLLED EL. BEPTH/EL SPOMD BATER 25.9/86 3 - 658.0 53.2 FT/604.8 SAMPLE MAMBER MEDIT/FALL CASONC LEFT OF MOLE DAL/ADOCTH HOONE LOGGED BY:  LAWRENCE TESTS  BATEA PRESSURE TESTS  BLEVATION  B BESCRIPTION AND CLASSIFICATION  B BESCRIPTION AND CLASSIFICATION	STJ BOOK STJ TOTAL DEPTH  38.0 83.0 FT  BEPTHYEL TOP OF BOCK  45.0 FT/663.0  FOLING  BETTES CON- BETTE
2/4/86 2/6/86 BROTCKE ENGINEERING CME-55 ATV 6 1/4"/3" 45.0  CONE RECOVERYOF JUD COME BOXES SAMPLES DL TOP OF CASAGE BROWN ELL BROTHVEL BROWN RATER  -25.9/86 3 - 658.0 53.2 FT/604.8  SAMPLE MARKET RESHT/FALL  CASING LETT BY HOLE DIA_ALDESTH  HONE  LAWRENCE Y  BATER  PRESSURE  TESTS  BLEVATION  BY  BESOMPTION AND CLASSFIRATION  BY  BESOMPTION AND CLASSFIRATION	MEPTILL TOP OF MOCK 45.0 FT/603.0  POLING  METER CIP SETUROL  MATER RETUROL
-25.9/86 3 658.0 53.2 FT/604.8  SAMPLE NAMEA RESIDENT/FALL  CASING LEFT IN HOLE DIA_ALDETH  HONE  LAWRENCE Y  RESIDENT  TESTS  REPATION  RE	/OLING  MOTES CO. MITTER LEVELS, MATER RETURN.
MONE  LAWRENCE 1  BATER  PRESCIPE  TESTS  ELEVATION  RESCRIPTION AND CLASSFILATION  RESCRIPTION AND CLASSFILATION	MOTES CON- UNITER LEVELS, UNITER RETURN,
TESTS  DESCRIPTION AND CLASSFICATION  DESCRIPTION AND CLASSFIC	WATER LEVELS, WATER RETURN
ELEVATION DE COMPTION AND CLASSEFILATION DE COMPTION DE COM	BATER RETURN.
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	MELING, ETC.
HOLLOW STEW AUGERS - NO SAMPLES  20  21  22  23  24  25  26  27  28  29  20  20  21  21  21  21  21  21  21  21	D-53.D FT DRILLEI WITH 6-1/4 IN O.D. HOLLOW STEM ALIGERS.
623.0 35	
SS-SPLIT SPOON ST-SHELEY TURG STE  B-COMMON P-PITCHER O-OTHER  EAST OF BUILDING 428	HOLE NO. G-2A



	G	E Ol	OGI	C DF	RILL	LC	OG M	NOJECT	FUSF	RAP	- MELDON SPRING SITE 14501-201 2 (	ec. er 3	G-2A
SAPE TIPE	ו האבור נמול אות	SAMPLE RECOVERY	AROMENT COME  SHOT IN THE STATE OF STAT	1085 )H G.P.R.	WATER RESSURE TESTS	THE IN MINUTES	ELEVATION	SS.	<b>201 SAPPRIC</b>	SMPLE	BESCRIPTION AND CLASSIFICATION	DUN	CHI LEVELS, RETURN, CTER OF INC, ETC.
							<b>605.</b> 0	45 - 50 - 53			·	ING FOR G-2. A WITHOUT TO 53.0 LOG OF FOR MAT SCRIPTI 0-53.0	3. D FT WITH NO INE CORE USING WATER
NO CORE	6.5'	4.3'	66					55 -		PON +1	ORANGE (10YR 6/6), SOFT, HIGHLY WEATH- ERED, 0.4 TO 0.6 FT CHERT LAYERS, HOR-	FORMAT ROI AP	GTON/KEOKUM 10N
IRE		0.4		5.0	9.5 15.0	32		60 -		1	60.3-60.5 FT FOSSILTEROUS ZONE.	RO AP LP '	UN #2 D = 0 X = 0.1 FT - 0.15 F7 UN #3 D = 34X = 0.3 FT
NO CORE	C. 0	8.7	87	1.8 2.4 8.6		14	586.3	70	书			RO AP	= 0.5 FT  UN #4  D = 700  = 0.4 FT  = 1.3 FT
			SPOON; S				583. 0	75	#	1	LOWISH BROWN (10YR 4/2) SHALE LAYERS,  EAST OF BUILDING 428	HOLE NO.	G-2A



_ 5	3 5	E	OGI		WATER		og [*	NO.JECT			- MELDON SPRING SITE JOB NO. SHEET 14501-201 3	or 3 G-2A
WAR BINGE	TENETH COM	COME MECON	MENCENT COM	1055 JN 6.P.R.	TESTS TESTS	TIME IN MIMITES	ELEVATION 583. D	75	901 DIMANO	STAME	DESCRIPTION AND CLASSIFICATION	WATER LEVELS, WATER RETURN, DHARACTER OF DRILLING, ETC.
2 0.	. 0 9.	6.	96			-	577.2 575.0	80 - 80.8		RUN 45	SOFT, 0.1 TO 0.5 FT THICK, HORIZONTAL- LY FRACTURED WITH ROUGH-PLANAR SURFA- CES, VUGGY, OCCASIONAL STYLOLITES.  BO.8-B3.0 FT LIMESTONE, MEDIUM LIGHT GRAY (N6), HARD, STYLOLITES, FOSSILI- FERDUS, MASSIVE, FRESH. BOTTOM OF BORING AT 83.0 FT. BORING GROUTED TO SURFACE ON 2/6/86.	RUN *5 RQD * 96X AP = 0.8 FT LP = 1.6 FT
												ROD=ROCK QUALITY DESIGNATION FOR EACH RUN AP=AVERAGE LENGT OF CORE PIECE LP=LONGEST PIECE OF CORE FROM EACH RUN.
												ALL SOIL AND ROC COLOR DESCRIP- TIONS FROM THE ROCK COLOR CHAR' PRINTED BY THE GEOLOGICAL SOCI- ETY OF AMERICA.



	G	EOI	LOGI	C DI	RILI	. LC	G "	n.ec		AP	- NELDON	SPRING	SITE		95 NO. 4501-2		MEXT (	но. or 3	HOLE BO. G-3
int N	DRTH	EST	OF COA	L-STOR	AGE AF	E A	COOPDINATES	3	NI	D1.	195.3	<b>W</b> 5(	948.6		N	CELE	FROM NO 90	ORIZ.	E MINC
(a)		100	PLETED 2/11/86	DRIL	LER	TONY	CALTRY NGINEERIN			W.E	AND MODEL E-55 ATV		HOLE \$120 6 1/4" 3		54.6	77.3		F7.)	TOTAL BEPTH 88.2 FT
	KCDV	EURY (F	T. /X)	COPE	BOXES	SMEL	EL. TOP		SHIZA	ERO	mo Eu.	DEPTIM	L. MOLAD	MATER			BC711/	EL. 70P	OF ROCK
MPI.		).5/9	EIGHT/FAL		4	11	IN MOLE: D	-   A. /L	EW6TH		LOCCED B	17.	65.55 FT	7/588.	45	]	<u> </u>	54.6	7/599.4
			S/30 IN				NONE							LAVR	ENCE Y	OUNC	;		
2	ADVANCE.	RCOVERY	2		MATER MESSUME TESTS			F	STAPHIE LOS	CAMERIC		<b>.</b>	TION AND C					<b>W</b> 1	ES BUI ER LEVELS, ER RETURN,
9	SAPPLER		M. WEEDER	1055 F. H.	P. S. 1	TIME IN MINUTES	ELEVATION .	METAN.	1 -	3		DESCRIP	130M 200 C	LASSIY I	CATION			DU	RACTER OF LLIBS, ETC.
				1	SND 6	1	653.5	0.5			0-0.5 F	T GRAV	ÆL, LIGH	T SRA	Y (N7)	,L]N	Œ-		FT DRILLE
					-				<u> </u>				AYEY SIL			1),		LOW ST	'EN AUGERS.
							650.0	4	朑	#-			LAYEY SI			FRA	ROMAI		•
\ ? <b>'</b>	18*	18"	17	1	6	11			]  [		(5YR 4/	41, N	DIST, VER	ITZ YI	FF, TR	ACE			
									IIIE		UNEN: 0	MONVEL.	•						
									3										
\ }'	18°	18"	16	4	7	9		10	4										
									<u> </u>	$\ \cdot\ $	-								
. c						<b> </b>		l . F	E	$\ \cdot\ $	4								
55 2°	18*	18"	22	5	9	13		15	111										
									4				•						
									3										
55 2'	18*	18*	26	7	10	16		20	4										
<u>.                                    </u>	F		-	-	+	<del>                                     </del>	}		<u> </u>	$\ \cdot\ $	1								•
									111										
	_	_		<u> </u>	-		-	25	3		-	ı.							
\$\$ <b>2'</b>	18"	18"	33	14	15	18		"	3111									DRIVI	NG COBBLE.
									4111										
									3										
55 2'	18"	18*	28	7	13	15	1	30	-4		5								
2.	-	<del> </del>	<del></del>	+ -	+-		-		<b>   </b>		-								
									4										
							619.0_	35	3		_								
	26-5	PLIT	SPOON; 5	1-SELET	Y TUBE:	1	I DIS.U	1		Ш. •••	THWEST O	- 654	PTARIAS	ADEA				HEALE MI	o. G-3



		C	ΕO	LOGI	C DR	ILL	LOG		PROLECT		FUSI	RAP	- WELDON SPRING SITE M501-201		or 3	MOLE MO. G-3
E			11000	C BLOWS		MATES PRESENT TEST!	RE	<b>SLEVATION</b>	2	T	2 2 2			1	T	LES CON
3				A POSCERI	<u> </u>	A ST	¥ = \$	60.0	35		Š	7	BESCHPTEN AND CLASSIFICATION		COL	TER RETURN. MACTER OF LLOSS, ETC.
33	1	18'	18.	23	151 6	200	30, 6			1		7			1	·
\$5 \$2	  -  -	8,	15*	39	15	18	21		40 -			•				
\$\$ <b>?</b> *	,	8.	14°	88	23	48	40	612.D	45			9	42.0-54.6 FT SILT AND BRAVEL, PALE REDDISH BROWN (18YR 5/4) TO MODERATI REDDISH BROWN (18YR 6/6), MDIST, ST SILT AND ANGULAR CHERT GRAVEL	i IFF,	DIOLOGED LOGGED LINE A	LE WAS RA- ICALLY BY EBER- MALYTICAL ATION PRIO ING.
\$\$ 2*	1.	4*	13*	70+	14	20	50/2*		50	*****					SAMPLE BLIRL IN KEOKUK	
72	1.	57	c.	50+	54/1.5	-	. /	599.4	54.6			<u> </u>	EAR CY B CY I LIGHT COME			,
NO CORE	8.	4'	5.7'	80	23.1 25.0 26.3	5 10 15	4 9 7	591.0	8			- 52	54.6-63.0 FT LIMESTONE, DARK YELLOW! ORANGE (10YR 6/6) TO LIGHT GRAY (NT MEDIUM SOFT TO MEDIUM HAND, EXTREMEL WEATHERED, HORIZONTALLY FRACTURED, IRON STAINED, FRACTURES FILLED WITH SILT AND CLAY, PLANAR-ROUGH SURFACES OCCASIONAL STYLOLITES AND THIN (0.1 0.2 FT) CHERT LAYERS.	), Y	DIAMONE USING I	WITH NO
€	8. !	5' 8	. 0'	94				351.V	63 - 65 - 70 - 70 - 70 - 70 - 70 - 70 - 70 - 7				63.0-80.5 FT LINESTONE, LIGHT GRAY (N7), NEDIUM HARD, NEDERATELY WEATH-FRED, WITH DARK YELLOWISH BROWN (1897 A/2) HIGHLY TO NODERATELY WEATHERED, SOFT ZONES Q.1 TO 0.8 FT THICK; HORIZALLY FRACTURED.	1	RCO AP - LP -	2/11/86 N •2 ) + 51X • 0.3 FT 0.65 FT
*		7" 6		100			IOTE	579.0	75						AP ·	• 72X 0.5 F7 1.0
	×				CHALLES		ant.				NO	RTH	WEST OF COAL STORAGE AFEA	-	N. B.	G-3



	G B/S	EOL	OGIC		BATER			ROLECT		WP	- WELDON SPRING SITE M501-201 3	er 3 G-3
10 Desc. 10	LENCTH COTE N	CON MICONIA	ACOUNT ON A STREET OF STREET ON A STREET O	(8 = 2 2 = 3	TESTS	¥ = \$	ELEVATION 579.0	75	81 June	31.est	BESCHIPTION AND CLASSIFICATION	BUTTON ELE BUTTON ELEMEN BUTTON
											,	
NU CURE	10.0	9. 1'	91				573.5	80.5		RUN O.	80.5-88.2 FT <u>LINESTONE</u> , NEDIUM LIGHT GRAY (NG), NEDIUM HARD, SLIGHTLY WEATHERED, HEALED HORIZONTAL FRACTURES FILLED WITH CALCITE, STYLOLITES.	RED = 4 RGO = 8CX AP = 0.4 FT LP = 1.0 FT
							<b>5</b> 65.8	85				
							303.0				BOTTOM OF BORING AT 88.2. BORING GROUTED TO SURFACE ON 2/11/86.	45 FT. OF 4 INC PVC CASING LOST IN THE HOLE.
											·	ROD-ROCK QUALIT DESIGNATION FOR EACH RL AP-AVERAGE LENG OF CORE PIEC LP-LONGEST PIEC OF CORE FROM EACH RLM.
									************			ALL SOIL AND RO COLOR DESCRIP- TIONS FROM THE ROCK COLOR CHAP PRINTED BY THE GEOLOGICAL SOCI ETY OF AMERICA.
									*********			
			PODIA STIS				int.		1		ATHMEST OF COAL STORAGE AREA	MALE NO. 6-3



	G	EOL	OGIC	DRI	LL I	. <b>0</b> G			FUSRAP	- XE	LDON !	SPR1NG	SITE	145	01-201	Softa 1	<b>#</b> 3	G-4
			TH OF A	ISH PON		20.0	COMPONITES		N101				,295.6	ONLINE		9	0	TOTAL BOTH
2/1/		2	/B/%		BRO	TOXE E	CALTRY NGINEERIN	<b>G</b>	C	ME-55	VTA	į	1/4/3	\$ 53			PLO TOP (	\$L0 FT
		2/94	}		3	SAPLE ID		•		644.0	)		SSLID FT/					T/59L0
			20 M		CAS	ו דיפוט או	HONE HONE	BETH			MCD In	/ B		LAURENC	E YOUN	<u> </u>	<del>,</del>	
BARETON	10 × 10 ==	Y STATE	THE ROPS		TESTS	THE STATES	BLEVA TORN	# <b>2</b>	Part 166	¥		ELCIP'II	M #9 (L/I	MATICATUDI			7110	ES ON THE LEVELS, THE SETTION, MACTER OF
3 2		18	3 12	3-3	1	20 %	644.0	0	1 - 1		205	TOLAY	EV 611 T	BLACK (	M1) A	<b>D</b> -	6-53	O FT DRILLED
				151 6		-	642.0	2				EBRIS.	<u> 3161</u> ,				HITE	S MIN OO HOL TEN AUGERS.
										M VE	DERAT	E BROW IFF, N	N (5YR 3 DIST, TI	<u>(y</u> - Clay 3/4), St) VACE TO !	FF TO	_		
\$\$ 2'	18°	16"	15	3	7			5	1//					r Chert ( Lenses.		•		
\$\$ <b>2</b> '	18"	18"	15	4	6	9		10		2								
\$\$ 2 <b>'</b>	18"	18"	21	5	10	11		15		3								
\$\$ 2'	18"	19.	28	6	13	15		20		4	,		•	•				
-																		
\$\$ 2'	18"	24"	27	8	13	14		25	*//	5								
4							1											
\$\$ 2*	18"	24"	24	1	10	14	-	30	<i>\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\</i>								·	
2"	-								1//	H		•						
					1		609. 3 609. 0	34. 35		Ц								
			Petro ST				en.				MOTIN	OF AS	H POMB	-			MAL I	G-4



	G	EOL	OGIC	DRIL	<u>.L L</u>	.0G	PRO	OJECT	FUSF	AP	- WELDON SPRING SITE JOB NO. SHEET NO. 2 o	
NO CIANETER	SAMPLET ADVANCE.	CONE RECOVERY	SAMPLE BLOWS  W PERCENT CORE  RECOVERY	, F	WATER RESSURE TESTS	S	ELEVATION	DEPTH	CRAPHIC LOG	SAUPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN. CHARACTER OF
2		300	SA PERC	S ₹ 3	SS 35. E 2ND 6'	3RD 6"	609.0	35_	8		·	DRELLING, ETC.
<u> </u>	18"	15"	69	24	40	29				7	34.7-50.0 FT GRAVELLY, CLAYEY SILT, MODERATE REDDISH BROWN (10R 4/6), HARD, GRAVEL IS PRIMARILY VERY LIGHT GRAY (NB) ANGULAR CHERT.	
2*	15*	15*	75+	11	25	50/3*		40 -		8		
					•			45 -		-		BOREHOLE WAS
\$\$ 2"	18"	10°	31	14	17	14		- כד		9		RADIOLOGICALLY LOGGED BY EBER- LINE ANALYTICAL CORPORATION PRIOR TO CORING.
SS 2*	18"	11*	48	20	26	22	594.0	50	4414	1(	(NB), SOFT, EXTREMELY WEATHERED, MIXED WITH MODERATE REDDISH BROWN (10R 4/6)	BURLINGTON/ KEOKUK FM.
	8'	6.2	78				591.0.	<b>5</b> 3		-	CLAY & VERY LIGHT GRAY (N6) CHERT GRAVEL 53.0-71.1 FT <u>LIMESTONE</u> , DARK YELLOWISH ORANGE (10YR 6/6) TO LIGHT GRAY (N7), MODERATELY SOFT TO MODERATELY HARD, VUGS (1 TO 3 CM), HORIZONTALLY FRAC-	53.0-81,0 FT DRILLED WITH ND WIRE LINE DIAMON CORING USING WATER. 2/13/8
NO CORE				17.2	5 10 15	9 10 13		60			I TIMEN WITH PLAY AND SILT FILLING AND	RUN +1 RQD + 50% AP = 0.3 FT LP = 0.5 F7
CORTE	10'	10'	100					65				RUN #2 RQD = 75X AF = 0.4 FT LP = 1.4 FT
₽							572.9	70	4		70.5 FT LARGE STYLOLITE 71.1-81.0 FT LIMESTONE, MEDIUM LIGHT GRAY (N6), HARD, SLIGHTLY WEATHERED, 0.1 TO 0.5 FT CHERT LAYERS AND NODULES, STYLOLITES.	ALL BREAKS IN TH ZONE APPEAR ME- CHANICAL AND ALONG STYLOLITES
					<u> </u>		569. D	75	王	9	STILOLITES.	HOLE NO.



Segundary 10' 10' 100 Segundary 10' 10' 10' 100 Segundary 10' 10' 10' 10' 10' 10' 10' 10' 10' 10'	- 1,	. 1		OGIC	WATER		Τ	103	$\prod$	- WELDON SPRING SITE M50!-201 3	or 3 G-4
RUN =3 RQD = 71 AP = 0.4 LP = 1.2  BOTTOM OF BORING AT 81.0 FT. BORING COLOR DESCR TIONS FROM ROCK COLOR PRINTED BY GEOLOGICAL SETY OF AMER  RQD-ROCK OU DESIGNA FOR EAC AP=AVERAGE OF CORE LP=LONGEST OF CORE	AND DIMETER	CINCTH CORE R.	SAPLE RECOVER	SAMPLE BLOWS  "Y PERCENT CONE. RECOVENY	TESTS			CRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	MOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
BOTTOM OF BORING AT 81.0 FT. BORING GROUTED TO SURFACE ON 2/13/86.  ALL SOIL AND COLOR DESCR TIONS FROM ROCK COLOR! PRINTED BY GEOLOGICAL! ETY OF AMER  RQD=ROCK OU DESIGNA FOR EAC AP=AVERAGE OF CORE LP=LONGEST OF CORE	3						80		•		RUN +3 ROD = 70% AP = 0.4 FT LP = 1.2 FT
						363. U					ALL SOIL AND ROCK COLOR DESCRIP- TIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCI- ETY OF AMERICA.  ROD-ROCK QUALITY DESIGNATION FOR EACH RUN AP=AVERAGE LENGTH OF CORE PIECES LP=LONGEST PIECE OF CORE FROM EACH RUN.



	G	EOL	OGIC	DRI	LL L	.0G			FUSRA	P -	WELDON !	SPR1NG	SITE	14501		PAGE I	<b>#</b> 2	HOLE HO. G-5
ITE A	DJAC	ENT '	TO ASH.I	DISCHA	RGE LI	INE	COOPERATE				,650	<b>V</b> 51	, 250			90		•
7/1	1/86	1	#LETED :	DOLL	D		HNOLOGY JAEGER	D	PELL MAN		10 14000. ME-55		6'/3"	40.0		MCX (	22.0 LL1	TOTAL BEPTY
	ECOM	ज्ञान .	<b>7</b> 0	CARE	BOKES	SAPL		& CVR	HC G	20.0	0 D.	HET THE S	-				D. TOP B	
AP.		13/% 10 E	MITTALL		3 CASE	8 6 UDT 1	DI NOLEI DAL	LDGTH		6.	55.9  L000ED P	<u> </u>	38.0/5	<b>3.</b> 0		<u> </u>	40.07	232.7
	HC	LBS	/30 N				NONE	<del>,</del> —	<del></del>	1				A ATKINS	ON			
	10 M	TO STATE OF	BROWS 1 COME 1 COME	·	BATER RESSARE TEXTS		ELEVATION	<b>E</b>	Server 166	3		BESCRIP TO	M MD CLAS	SEELTON	•			EN SELVENT EN TEACTY ET EN
AND DAME TO	D MAN	8	PRODUCE OF THE PRODUCT OF THE PRODUC	2 = 3 2 = 3	7	THE TREE TO SERVICE	635. 9		8	3							Cast Bits	PACTER OF LOSE, ETC.
¥\$							634.9		$\approx$					EBRIS, GR RADIENTS,	ASS,			FT DRILL
= ا و:									<b>1</b>		1.0 TO	7.0 FT	CLAY SI	LT/SILTY			LOW ST	TEM AUGERS
									<b>!</b>					AY (10YR : ACK FRAGM			nziwe	CENTER PL
SS 2*	18*	2.5	26	9	12	14		5	1	55-								
子								:	<b>1</b>									
1	24"	22'					628.9	7						<u> </u>				
3.														<u>Clay</u> , yel Orange (		H	BOREHO	IO.O FT. DLE WAS
3 <b>.</b> j	18"	0	27	10	14	13		10 -		1	5/5) AN MOIST,			), VERY S	TIFF,		RADIOL LOGGE	DG CALLY
5A 55 2*	18*	3.5	23	9	10	13				-S	10.5.,	110106					EBERL!	INE
ž	-		•					:	<b>\</b> //	1								RATION.
£	18"	•••	17	6	9	8				<del>}-</del>								
5.	10	1.6				•		15 -		严								
¥SA							618.9		1//	1								
ا ما							910.3	17	1111					Y SILI, C		iH.		
\$\$ 2*	18"	21'	23	7	13	10			<u> </u>	3				TH DRANGE STIFF, NO				
					-	-		20 -	#	12	,							
HSA		ļ !					613.9	22	$\mathbf{W}$	ļ							Į	
9									<b>?</b>					LLY CLAY				
<u>د</u> د 2'	181	18'	50	18	23	27			1/2	55.5	6/6) VE	RY ST	FF TO M	TO YELLO URD, MOIST	, WI	H		
								25	1/2	1			(N9) TO 6/6) CHE	) <mark>Dark yel</mark> Irt.	LOVIS	H		
			ĺ						12	1								
									1/2	1								
<b>5</b> 5	18"	16"	29	13	17	12		30	1/2	100							1	
4			·						1/2	7								
7X .9		<u> </u>							<b>}</b>	7								
		4:0	50 (0)		50/2*				<b>13</b>	٦,	1							
[2	6.	11.	50/21	43	3U/2"		600.9	35	<b>₹</b> /	<u>}</u>	1						<u> </u>	· · · · · · · · · · · · · · · · · · ·
			57+9H			*	M		A	ונפ	MENT TO	ASH D	SCHARGE	LINE				G-5



	G	ΕO		GIC	DRIL	L L	.0G	<b>—</b>	O.E.C.	FUSA	WP	- WELDON SPRING SITE 450-201 2 6	_
10 TO 10 TO	ST RE	LO MANON	I BLOWS	PERCENT CONE RECOVERY	•	BATER TESTS		BLEVATION	ML COM	DELINEC LGC		BESCHPTION AND CLASSFICATION	MATES ON MATER LEVELS, MATER RETURN. GRAPACTER OF
1 8			3	PERC	2 = 3	3	7 m m	6003	35	8			BRALINA ETC.
TRICOTE 6" HSA								<b>59</b> 5. 9	40 -			·	38.0 FT AUGER REFUSAL.  8/4/86 38.0 TO 40.0 FT DRILLED WITH 6-IN
	3.0	3.0		100				333. 3			E NE	BEIGE, MODERATELY TO LOCALLY EXTREMELY MEATHERED, MODERATELY HARD, MODERATELY TO EXTREMELY FRACTURED, WHITE TO GRAY,	TRICOME ROLLER BI AND WATER. 40.0 TO 73.0 FT CORED WITH NXB
	5.0	5. (	,	100					45 -		75 VS	VERY MARD LAVERS AND PATCHES OF CHERT. 40.0 TO 40.1 FT CLAY SEAM. 46.6 TO 47.0 FT CLAY SEAM.	WIRELINE DIAMOND IMPREGNATED BIT USING WATER.
			1		0	20	5			扭			BURL INGTON/KEOKLE FM.
I DIAMOND BIT	4.7	4.7	7	100	C	30	5		50 -		SE SE		AP (P 80 BUH (FT) (FT) (2 1 0.1 0.4 21 2 0.2 0.5 3 0.2 0.7
BAPPEL WITH	4.3	3.	,	86					55		T T	55.8 TO 58 FT QUARTZ FILLING.	3 0.2 0.7 4 0.2 1.6 6 0.2 0.8 5. 7 0.2 0.8 5. 8 0.3 0.8 7.
KXB COPE	1.0	0		0	0	20	5			基	<u>-</u>		
2		3.		72	0.02	30 20	5		60				ROD-ROCK GLALITY DESIGNATION FOR EACH RU
	5.6	4.	8	<b>%</b>					65		HHHHH		AP=AVERAGE LENG OF CORE PIECE LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROS CON OR DESCRIB-
	5.0	5.	.8	100				568.4	70	HHHH		67.5 TO 73.0 FT LINESTONE, BLUE-GRAY, FRESH, HARD, CRYSTALLINE, WITH OCASSIGNAL LAYERS AND PATCHES OF WHITE AND GRAY CHERT.	COLOR DESCRIP- TIONS FROM THE BOCK COLOR CHAR PRINTED BY THE BEOLOGICAL SOCI ETY OF AMERICA, 1948.
								562.9	73			BOTTOM OF BORING AT 73.0 FT. BORING GROUTED TO SUFFACE ON	
					MG. 37 7			SET E			AC	JACENT 70 ASH DISCHARGE LINE	G-5



7	<u>~</u>											<del></del>	- A	Sec.		HOLE HO.
	C	EOL	OGIC	DRII	<u>LL l</u>	<u> </u>			FUSRAP	, <u>.</u>	WELDON !	SPRING SITE	14501-20		<b>#</b> 2	C-6
τ		SOU	TH OF AS	SH PON	D		COOPDONTES			-	, 450	<b>V</b> 51,150		90		•
/17/	7/83		FLETED 5/20/86	KURT		OTECHO	NOLDGY INC	<b>ا</b> دا	CHE		0 1600. 5/01/E-750	1	23.5		435	TRIAL BEPTH
	RECOVE	Diff	∕no		BOKES 4		15 0-10					ED THEL COME BATT	782		23.51/	
	LE mma		DBIT/FALL			1	B RELIEVA	LDETH			LESSED DY	71				
<del></del>	H0	LBS/	/30 N		SEATER.		NONE	<del></del>	<del>1  </del>	П			LAIMENCE YO	NG		
E	E 12	4	E 80 E		TESTS			Ę	8 2	2	ı	DESCRIPTION AND GLASSI		!		AN ILLIAN MATERIAL MET CON
-		1 NO	SAMPLE BLOWS  W  THE CONTROL  T	2=4	Ka '	M. P	DLEVATION	100	1	3	•	ALIGH THE HOUSE	PEA Inc.	1		MACTER OF LLOSS, ETC.
3	ELE	3/2	3 IE	5-5	**	20 6	639.7	0		4	~ 70 16	S. O FT SILTY CLA	MATERATI		10-23.	5 FT DRILLES
1	1	1	1 1		1 1	1 '	1		<b>*//</b> )	7	15YR 4/	(4), MOTTLED WITH	H MEDIUM LI	ICHT	WITH (	6 VAIN DO HOL TEN AUGERS
1	1	1	1		1 /	4		-	<b>Y//</b>	1	VERY ST	S) SILT LENSES, I	SOME FINE CA	RAVEL	USING	CENTER PLU
s I	18°	12"	14	4	7	7		:	1//			RILY IDEOUS AND PYROLUSITE STR		CONTUS-	0 TO	10.0 FT BOR
-	H	$\ddot{\vdash}$		-	الله	1	1	5	1//	H	1	-			LOCCE	
1		1	1		<b>i</b> '	1			1//	1	l				ENERL!	INE
-		1_1			'			:	1//	Ц	I					RATION.
Ş	18.	18*	18	3	8	10	į		<b>\//</b>	2	•				776	/20/86 *
7							1	10 -	1//	刀	1				4	
ST 3°	2'	7'	PUSHED	700	×i.	<del> </del>	1		¥//	扫	1				BY IN	DE AFFECTE
				1	<del> </del>	<del> </del>	4		1//	H	ĺ				BREAK	LDOWN OF
\$\$ ?"	18"	18"	19	6	8	11	4	15 -	¥//	4	l				į	BY TUBE STUC
_'		<u> </u>	<u>  '</u>				623.7	16	1	1		0 23.5 FT GRAVEL			IN HO	LE. DROVE
57 3*	2'	0,	PLESHED	9 100	D PS1			:	16	5		ISH ORANGE(10YR IGHT GRAY(N7) AN			TATE	TUBE TO
ડુડ	3"	3,	50+	50/3"	<del>                                     </del>	+	4	:	39	垣	1				RE COV	
لا	+	-	+	-	<del> </del>	+		20 -	1	1	1				REFUS	,
1				1					*//	1					USED	TO 25.0 FT
•				,			616.2	23.5	*2	4	<u></u>		* ' ' *			TO START CO
_				]			-	25 -	井		BROWN!	O 40.0 FT LINES! SH GRAY (SYR 6/)	1), NEDIUM	SOFT		TD 67.0 FT
100	2.0	2.0	100		İ			-	田	1	TO NED!	IUM MARD, SEVERE DOERATE BROWN(5)	ELY WEATHER BYR 3/4)QLAY	ed, Eng,	COPE	D WITH NOR
		-	<del> </del>	1				1	井	4	CHERT (	GRAVEL, SEAKS UF ESS, INTERBEDDEL	P TO 1.5 FT	IN	INFRE	EGNATED BIT
rire .ine	ed .	1.0	33						宝	12	CONFETT	ESS, INTERECUEL	S OR LAYERS	<b>.</b>	CLEM	g water and r nld.
CORE	4							30	井	d			i			ရှာ ရှာ ရှ
NC3	+			1					世						1 2	A1 A4 3
TRE	E 9.0	1.3	14					'	出	15						
380	1						604.7	35	臣	4=1						
			Petra 57-10			1	#7TL	<u> 1 ~</u> .	ــطـ	<u>۔۔</u>	CUILH.	OF ASH POND			HELL HE	G-6
	-	<u> </u>	MICO	A COTE	<u> </u>						<b>30</b> 111	Ur ABN 1 mm			——	



	G	EOL	OGIC	DRI	LL I	.0G	n	ROJECT	FUSI	w	- WELDON SPRING SITE JASS NO. SMEXT 450-201 2	MD. MDLE MD. MF 2 G-6
LE TYPE METTER	David M	AND AND AND AND AND AND AND AND AND AND	E BLOWS		BATER TESTS	<u>.</u>	BLEVA Tribe	жы	7EC 108	7	BESCRIPTION AND CLASSIFICATION	MATICS COR MATION LEVELLS. MATION RETINORS.
1		1 E	3 5	<u>8</u> = 3	3.	A . E	SOL7	35	1	2		SOLUBIA, ETC.
MXB FIRE- LINE CORE	9.0	8.2'	91				593.7	40 -		RUN 04	40.0 TO 54.0 FT LINESTONE, DARK YELLOW- ISH ORANGE(18YR 6/6), NEDIUM HARD, NODERATELY WEATHERED, VUGGY, OCCASIONAL STYLOLITES, HORIZONTAL FRACTURES WITH ROUGH - PLANAR IRON STAINED APERATURES.	# (FT) (FT) (X) 3
	4.0	3.0'	60				585.7	54 -		UN +6 RUN +5	49.0 TO 54.0 PT SEVERELY WEATHERED ZONE, BROKEN, IRON STAINED.  54.0 TO 63.2 FT LINESTONE, BROWNISH GRAY(5YR 4/1), HARD, MODERATELY WEATHERED, NO APPARENT FRACTURES,	ADDED 4 GALLONS OF BLEACH TO BREAK DOWN CLEAR MLD. HOLE CAVED AT 26.0 FT WHEN MLD BROKE DOW NO PACKER TES. WERE PERFORMED.
NOORE. NOORE. LINE. LOORE.	7.0'	8.0	114					60 - 63.2 65 -		N OF NAME OF N	63.2 TO 67.0 FT LINESTONE, MEDIUM GRAY (NS), MARD, SLIGHTLY MEATHERED, STYLOLYTIC.	NOO-ROCK GUALITY BESIGNATION FOR EACH RUN. AP-AVERAGE LENGTH OF CORE PIECES. LP-LONGEST PIECE OF CORE FROM EACH RUN.
							572.7	67		2	BOTTOM OF BORING AT 67.0 FT. BORING GROUTED TO SURFACE ON 6/20/86.	ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.
			POOD STAN			18	m.	1		٠	SOUTH OF ASH POND	mus m.



_	$\frac{1}{G}$	EOI	OGIC	DRII		OG		HOLECT		 p -	WELDON	SPRING SIT	TE	14501		SHEET	<b>1</b> 2	HOLE NO. G-7
ΠĘ							COOPENATES					<b>¥50,45</b>			MELL	FROM H		SEARS.
			TH OF CO	DAL PIL		OTECH	NOLOGY INC	r 0	DELL MAK	KI M	1,200 MD MODEL	in.	T POI	OFFICE		880x (	€13	TOTAL BEPTH
<b>/17</b>	/83	6	5/18/86	KUR	T JAEG	CER/CEC	ORCE MATTE	HEWS			5/OHE-750	FINEL OF	V4/3	B.5	<u> </u>		MEL TOP O	64.0°
<b>托</b> 1		5me7. 4.7/63		Can	4	3		<b>6</b> Co-			333		4.201/59				B.5'/	
	E NAME		/30 N		CASE	E UT	IN MOLES DINAL	METH			LOSSED BY	rı .		LAURENCE	YOUN	r,		
		LBS/	/30 5-		BATER		10000	Т	T	П	<del>                                     </del>			Paris			Π	_
E	E 8		LE PLOPS	<u></u>	MESSURE TEXTS	<del></del>	<b>DLEVATION</b>	# D	DEPTE 160	1	1	BESCHPTION A	## BLAS	SFEATEN		1		TES COM TORN LEVELS, TORN RETURN, MONETER OF
8		12	ACCINAL PROPERTY OF THE PROPER	8 = 3 8 = 3	(A. )	A = E	633.3	0	1				<del></del>			·		ELEMA, ETC.
										1	TRACE TO		DIST, S' Bround	STIFF TO VE DED TO ROI	ery sti Xunded	FINE	FOR 2.	5 FT DRILLE 6 VAIN OD HO TEN AUGERS
S		13*		3	5	8			1//	4	DRIGIN)	(PRIMARILY ), MOTTLED ENSES, PYR	HTIW D	LIGHT GR	RAY(NE		USING	CENTER PL
•	18	دا ا	13	3	5	6		5	<b>///</b>	+	316. 22	NOLU,	NLUL.	i <b>E</b> · ₩ +++ c	Antro.		HOLE	10.0 FT BO
								:	¥//	1   1							BY EN	CALLY LOGGE WERLINE PTICAL
5	18"	15°	20	5	8	12		10 -	<b>///</b>	12								TO 19.0 FT
							621.8	11.5	<i>\\\\</i>	1		0 18.5 FT	-orAt	A A	nar.		2-7/8	ED WITH
1		_ !						•			YELLOW!	D 18.5 FT ISH <b>ORANG</b> E EATHERED A	£ (10YR	( 6/6), MC	DIST,	HARD,	ROLLE	ER BIT AND HEATER TO COREHOLE.
इ	13*	9.	50+	32	50/5'	-	1	15 -	***	31	COBBLES	-					19.0	T COREHOLE. TO 21.0 FT D WITH NOOB
1		1							<b>3</b>								VIREL IMPRE	INE DIAMON
-							614.8	18.5	赵	<u>}</u>		0 37.0 FT					21.0	G CLEAR WA' TO 27.0 F' LED WITH TI
DOB	2.0	1.9	95					20 -	出	1	YELLOWI HARD, S	ISH DRANGE SEVERELY Y	E ( 10YR WEATHE!	R 6/6), ME RED, WITH	DOERAT 'H SEAI	ws of	CONE	ROLLER BI'
									汉	3	AND CHE	TE REDOISH ERT GRAVEL OR HODULE	L, SEN				27.0 CORED	TD 64.0 F
									1/3	1	21.0 TO	0 <b>26.0</b> FT	CLAY I	FILLED C	AVITY	HITE	INFRE	LINE DIAMO EGNATED BI G WATER AN
								25	赵	4	COME DU	UST OR FLY	Y-ASH I	MIXED WIT	TH CL	AY,	l manur	R MUD.
NO®	-1	+	+		-	+-	-		哲	#								AP LP (
INE OFE	<u> </u>	1.1	91	10.6	1	5		30	莊	重					•		3	6.3 6.2 6.3 6.2 6.2 6.2
102				12.2	10			<b>.</b>	开	1								
VIRE INE	7.0'	1.3	19	-	+	+-	1		井	神	H						V	1/18/86
		<u></u>		<u> </u>	<u> </u>	<u></u>	598.3	35	芷	7	1						MAL III	,
			PRODUSTIONS			[	#IL				NORTH	OF COAL I	PILE					G-7



	G	ΕU		OGIC	DRI	LL I	OG	P	DECT.	FIR	ZAP	- WELDON SPRING SITE M50-201 2 (	
		ROWDE	TO SECOND	N E		BATER FESTS		ELEVATION	***	and I seemed	7	SCLASSFTEN AND CLASSFEATON	MOTES DO BATER LEVELS, BATER METABLE
38		3		100	3= 3	PRESSURE P.S.ª	3 = 52 525	598.3	35	1	3		BOLLEGE ET C.
			1					596.3	37			37.0 TO 55.6 FT LINESTONE, DARK YELLOW-	RD = 44X
NXB VIRE INE CORE	8. D'	5.1	<b>7</b> ·	71					40 -		Z	ISH GRANGE(10YR 6/6) TO MODERATE YELLOW- ISH BROWN(10YR 5/4), MODERATELY HARD, MODERATELY TO SLIGHTLY MEATHERED, YUGGY, STYLOLITIC, THIN (UP TO 0.3 FT) CHERT LENSES, MORIZONTALLY FRACTURED WITH SMOOTH-PLAMAR IRON STAINED APERATURES.	AP = 0.3 FT LP + 0.5 FT
NXB VIRE INE CORE	9.0	7.4		84					50		RUN 65		RUN #5 ROD = 21X AP = 0.3 FT LP = 0.7 FT
NXB VIRE LINE CORE	10.6	9.	0'	90				577.7	55 55.0		20	55.6 TO 64.0 FT LINESTONE, MEDIUM GRAY (N5), MARD, SLIGHTLY WEATHERED TO FRESH MEDIUM LIGHT GRAY(N6) CHERT LENSES, INTERBEDS OF DARK GRAY(N3) TO BARK GREENISH GRAY(SGY 4/1) SHALE, STYLO-LITIC.	PLIN +6 RCD + 53X AP + 0.3 FT LP + 1.5 FT
								569.3	64			BOTTOM OF BORING AT 64.0 FT. BORING	OF BLEACH TO HOLE TO BREAK DOWN CLEAR MUD.
										*******************		RECUTED TO SURFACE ON 6/18/86.  RECUTED TO SURFACE ON 6/18/86.  RECUTED TO SURFACE ON 6/18/86.  RECUTED TO SURFACE ON 6/18/86.  RECUTED TO SURFACE ON 6/18/86.  RECUTED TO SURFACE ON 6/18/86.  RECUTED TO SURFACE ON 6/18/86.  RECUTED TO SURFACE ON 6/18/86.  RECUTED TO SURFACE ON 6/18/86.  RECUTED TO SURFACE ON 6/18/86.  RECUTED TO SURFACE ON 6/18/86.	ALL SOIL AND BOCK COLOR BESCRIP- TIONS FROM THE BOCK COLOR CHART PRINTED BY THE BEDLOGICAL SOCI- ETY OF AMERICA, 1948.
$\vdash$				COM STA			1	STE	1	1		MORTH OF COAL PILE	IRLE III.



πĸ	G	<u>EOl</u>	LOGIC	2 [	)RIL	<u>L</u> L	<u>0</u> G	COORDONTES		FUSRAP	<u>, -</u>	WELDON	SPRING	SITE	14501	1-201	SHEET I FROM H	<b>#</b> 3	G-B
			T OF B		. 407		<u> </u>					, 450		900 INDLE SEE	OVERNARDA		90 800x 6	0	TOTAL BEPTH
/16/	/86	6	6/18/86	1	KURT	JAEG	ER/GEO	OLDGY INC.	HEWS	CHE	E-45	5/CME-750	٥	6-1/4/3	30.0		1_4	<b>45.0</b>	75.0
		3/92	2		1	BOKES 5	SMPLE:		-			6 E. 55.3		52.2760	-		-	30.0°/	/625.3
Ā			10017/FAL			CASM	Î Î	N NO.E. DALALI	DETH			LOGGED 0	Ñ.		LAWRENCE	YOUN	<u> </u>		
AND DEMETER	2 × 2	CONTRA	MACDIL CON	OWEN	PR	MATER RESSURE TESTS		<b>ELEVATION</b>	PE AND	PERMIT LOS	S.M. S.		BESCRETI	2A.2) (8N H3F	SSFICATION			100	TES DIE TER LEVELS. TER RETLEM,
8	LOCAT CON	38	N DEF		<u>\$</u> = 3	7.4	A TO	655.3	0	8	1				<u>-</u>				MACTER OF BLUMB, ETC.
1				1	1			654.8	0.5	177	人	D TO 0.	.5 FT G	RAVEL N	EDIUM GRA	AY (NS)	ADBED		D FT DRILLER
	1						1	1	:	¥//	1	0.5 70	15.0 F	T SILTY	CLAY, DAR	RK CRE	EENISH	LOW ST	TEM AUGERS CENTER PLU
5	18"	5.	6	+	3	3	3			1//	7	BROWN	10YR 5/	/4) <b>, M</b> DIS	ST, MEDIUM TH MEDIUM	M STIF	FF,		
-		-	+-	+	-	<del>,</del>		1	5	1//	۲		ENSES,		ZONES NE			0 10	10.0 FT
	1					, 1	1 '			¥//	1	UT Service	i.					BOREH RADIO	HOLE WAS DLOGICALLY
	<u> </u>	<u></u>	<u></u>	+	_		<b> </b>	1	,	1//	4	-						LOGGE EBERL	ED BY
Ş	18"	13"	13	+	2	5	8	1	10 -	¥//	12							ANLY	YTICAL ORATION.
	<u></u>			+	_		<u> </u>	1		1//	1								
'	2.0'	2.0'	Р	"LEHE	ED •	700 P	<b>5</b> 1		•	¥//	13								
Ş	18*	19"	12	1	4	5	7	640.3	15 -	¥//	1								
-						1		044.5	1"	3//	1	(5YR 5	5/6), NC	DIST, VER	Y CLAY, L' RY STIFF,	SOME	BROWN		
1	'					1				¥//	1				TRINGERS.				
.s.	18"	21"	17	+	4	6	11			1//	<del>1</del> 5	,†							
			<del>                                     </del>	+	1				20 -	\$//	7								•
57 3°	2.0	2.0	<u>,</u>	PUSH	FD •	700 P	) <u>.</u>			\$//	٦,	1							
SS	<del> </del>	+	-	$\dashv$	6	7	11	1		¥//	7	,							
2'	-	-	+	十	-			629.3	25 26	4//	7	1						AUGE	R REFUSAL
					1			\$23.0	20	<b>1</b> /2		BROWN	(5YR 6/	/6) TO DAI	ELLY CLAY	WISH D	DRANCE	AT 30	R MEFESAL 30.0 FT. 3 TO 75.0 FT
<u>इड़</u>	11-	<del> </del> ••	50+	+	5	50/	_	4		<b>17</b>	4	T(NB).	MODERA"	ITELY WEAT	IARD, VERY THERED, A TO SOME F	angul a	AR	DRILL	LED WITH NO INPRECAU
<u>2</u> -	1/2	+	+		12.1	5-1/2	9	625.3	30	*	#	SANO.			STONE, DA			CORE	BIT AND SH MATER.
NXB 17 RE	-		91	_ 1	13.2		1	4		35	4	ISH OF	RANGE(1 ELY NEA	ATHERED,	WITH MODE	TELY S ERATE	SOFT, Brown	N -	RD0 = 30x
INE ORE	E   10.0	0 9.0	90	+	4		+	1		3	7	E (SYR 3	3/4), C	CLAY SEAM	S WITH CH	HERT C		L A	AP - 0.4 FT
					15.5	5	6	\$31:9	345	业	丑								LP • 0.5 FT
-			\$700m \$1					<b>S</b> ITE				EAST	OF BL!	DG. 407				HOLE III	G-8



	<del>-</del> ,-	G	E01	_OGI	IC	DRI	LLL	_0G		PROJECT	FUSF	RAP	- WELDON SPRING SITE	JOB NO. 14501-201	PET 2	NG. OF 3	HOLE NO.
SAMPLE TYPE	SAPLER ADVANCE	COME RIAN	SAMPLE RECOVERY	SAMPLE BLOWS  W	RECOVERY		WATER RESSURE TESTS		ELEVATION	DEPTH		SAMPLE			<u> </u>	MOT	TES ON:
3 5	3	LENGTH	300	SALPP	MEC	S = 3	PRESSURE P.S.J	Tare Manual Ma Manual Ma Manual Manual Manual Ma Ma Manual Ma Ma Ma Ma Ma Ma Ma Ma Ma Ma Ma Ma Ma		35	CRAPHIC LOC	WS.	DESCRIPTION AND CLASSET			Off	IER RETURN, IRACTER OF LLING, ETC.
XB IRE INE ORE	10.1	0'	7.7′	77		<b>16.</b> 0	Ю	8	613.3 611.3	40 42 44 45		RUN "2	34.3 68.7 FT LIMESTONE, (5YR 4/1) TO DARK YELLOW (10YR 4/6), MODERATELY H TO SLIGHTLY WEATHERED, S CHERT LAYERS OR NODULES, FRACTURED WITH IRON STAI FILLED ROUGH-PLANAR APER 42.0 TO 44.0 FT CLAY FIL	/ISH ORANGE HARD, MODERA HTYLOLITIC, ' HDIZONTALL' NED AND CLA' ATURES.	TELY VUGGY	R AP	RUN #2 ROD = 52% = 0.3 FT = 0.6 FT
XB IRE NE NE	1	)   7	'.6'	95						55 1	Щ;	FIN #3	52.6 TO 58.0 FT BROKEN Z	ONE.		R AP	/IB/86  RUN *3  ROD = 33%  P = 0.3 FT  P = 0.5 FT
XB RE NE NE	7.0	)' 7	.0´	Ю						66		Y WIN				R(	RUN •4 OD = 55% = 0.3 FT = 0.7 FT
® EL NE RE	10.0	Y 10	.0.	юо					<b>586.6</b>	68.7		2	68.7 TO 75.0 FT <u>LIMESTONE</u> GRAY(5YR 4/1) TO MEDIUM G SLIGHTLY WEATHERED, CHERT VUGS IN CHERT.	RAY(N5), HA	RO TH	RC AP	RÚN *5 DD = 39% = 0.3 FT = 0.7 FT
_	23:5	_ <u>_</u> \$ <b>&gt;</b> 1	50	ON, STES	HELI	BY TUBE;		\$112		75 +			EAST OF BLDG. 407	-	100	OLE NO.	



	G	EOL	OGIC	DRII		.0G		PROJECT	FUSF	RAP	- WELDON SPRING SITE JOB NO. SHEET NO. HOLE NO. 1450:-201 3 of 3 G-B
AND GIAMETER LAMPLER ADVANCE	LENGTH CORE PLAN	SAMPLE RECOVERY	SANPLE BLOWS  NO PERCENT CORE RECOVERY		WATER RESSURE TESTS		ELEVATION	DEP TH	GRAPHIC LOG	SAMPLE	MOTES ON WATER LEVELS, DESCRIPTION AND CLASSIFICATION WATER RETURN. CHARACTER OF
AND DAME SAUTER A	LENGTH CO	314 3403	A SAMALE E	LOSS R R C.P.M.	PRESSURE P.S.1	TME N N N N N N N N N N N N N N N N N N N	5BO.3	75	OMBHO CHAIRE	NIS	
									***************************************		
			SPOON, ST				SIE		]		EAST OF BLDG. 407



	G	EOL	OGIC	DRIL	L L	OG					WELDON S	SPR1NG	SITE	1450	1-201	1	<b>y</b> 3	G-9
π	A.	JACE	NT TO B	LDG. 4	110		COORDONATES		N	100	, 065	<b>W4</b> 9	<b>, 90</b> 5		AMBLE	FREM 16	<b>40.</b>	SEARC .
6/12		1	PLETED ./16/86	DRELL	DR GEO	TECHN	OLDGY INC	÷.	DRLL MAI		0 1000. NE-45		6-1/4º/3'	OVER-1800		NOCK (	LT.	TOTAL BEPTS 76.0'
	ECOVE	RTE .		COPE	BORES	SAPLE		er cas	. Sec   60	HOLIN	D &L.	NC THE	- 0000 14	TO			D. TOP O	F ROCK
***	-34.		BR/FALL		4 Cusan	9	H HOLE DALA	- LDGTH		6.	LONGE B	<u>.                                    </u>	43.47"/6/	X6.53			37.51	68.5
	140	LBS	/30 N				NONE	<del>,</del>		-	<u> </u>			LAWRENCE	YOUN	C ,		
AND DRAETER	Davids &	TOWN TOWNS	FAMPLE BLOWS  WENCENT COME	H	BATER MESSURE TESTS	•	ELEVATION	E	301 DAME	SAPLE.	. 1	<b>MESONPT</b>	On AND GLAS	SETCATION				
1	THE STATE OF	38	3 E.	8=3	2.5	A = P	<b>65</b> 6.0		1								<b>10</b>	ALEG, ETC.
									111				JETY CLA			ıcx	0-37.	FT DRILLI
									<b>3</b> ///		0.5 TO	26.0 F	TRACE CH	CLAY, NEC	IUM (	RAY	HOLLO	Y STEN AUG
, .		· ·							<b>¥//</b> /	$\sqcup$	OXIDIZE		STIFF TO	VERY STI	FF,		USING	CENTER PL
<u>ي</u> ک	18"	12"	17	3	8	9		5	<i>\$///</i>									
									<b>Y</b> //								8 70	10.0 FT
57	2'	2'	PUSHED 500 PSI		-				<i>\\\\</i>	2							BOREH	OLE WAS
22					_				1//	}_							LOCCE	
\$\$ 2*	18"	17°	15	4	7	8		10	¥//	<b>13</b>							EBERL ANAL Y	
								-	1//	1								RATION.
									*//									
\$\$ 2*	18"	19"	10	2	4	6			<b>Y</b> //	1						:		
2"	16	13	10	-	•	-		15	<del>1</del> ///	<b>/</b> -								
							640.0	16	*//	1			FT SILTY					
ST	5,	2'	PUSHED 500 PSI	-	-	•			<i>\\\\\</i>	5	(5YR 5/	6), N	DYR 6/6) Dist, Ver	Y STIFF.	SOME	SUB-		
<u>\$</u> \$	18"	18"	18	4	8	10			1//	16	MORPHIC	COMP	GRAVEL ( SITION),	PYROLUS	ITE A	ND		
2	<del>                                     </del>	-						20	<i>\\\\</i>	7			TRINGERS, (5) SILT		AllH	•		
							İ		1//	1		<b>—</b> 1	10, 511,					
									1//									
\$\$ 2'	18"		17	4	7	10			<b>¥//</b>	7								
-	T						630.0	25	<b>1</b> //	1								
							9,00,0	"	3				FT CRAVE					
2.			<u> </u>				]		3	1	STIFF 1	O HAR	N(10R 4/6 D, L1GHT	CRAY(N7)	ANGU	LAR		
<b>5.</b> 28	11.		74+	24	50/5"				129	1.	CHERT	RAVEL	, trace f	INE-GRAI	NED S	AND.		
							]	30	1/	1	]							
									*									P9 B0555
35			<del> </del>	-		-	-		*/	1	}						INTER	
<b>5</b> ,	18*	3'	18	12	10	8	621.0	35	12	19							1	ABILITY TE
			POOR STEEL			ľ	M1T				ADJACENT	TO B	LDG. 410				MOT M	G-9



	G	EOL	OGIC	DRIL		.0G		ROJECT	FUSF	MP	- WELDON SPRING SITE JOB 10. SMILT W501-201 2	et 3 C-3
BO DAMETER	LINCH DOLLAND	OR RECOVER	MECONENT CONT.	S = 4	MATER MESSAGE	¥ = 5	ELEVATION	Brain		SAMPLE	RESCRIPTION AND CLASSIFICATION	MATER ONE  SATER RETURN  CONNECTED OF  MILLION, ETC.
	315	315		- 3	F.	- 5	621.0	35	4.4	$\sqcup$		
IOGS WITCLINE	<b>5.5</b> ′	5.2*	94				<b>68.</b> 5	37.5 40 -		RUM of	37.5 TO 65.0 FT LIMESTONE, DARK YELLO- WISH ORANGE(10YR 5/4), MODERATELY WEATHERED, MODERATELY HARD, FOSSILI- FEROUS ZONES, WUGGY, HORIZONTALLY FRACTURED, CHERT LENSES UP TO 0.3 FT THICK.	37.5 TO 38.0 FT DRILLED WITH 2-7/8 INCH ROLLER BIT USING WATER. 38.0 TO 76.0 FT DRILLED WITH NXB WIRELINE DIAMOND CORE BIT USING
NXB WRELDE NO	7.5'	5.2	69					45.2 45.2 47.2		RUN '2	41.5 TO 41.9 FT CAVITY, FILLED WITH MODERATE YELLOWISH BROWN(1DYR 5/4) CLAY AND ANGLEAR CHERT GRAVEL, SMOOTH-PLAMAR APERATURE. 45.2 TO 47.2 FT CAVITY, FILLED WITH MODERATE YELLOWISH BROWN(1DYR 5/4) CLAY AND ANGLEAR CHERT GRAVEL, ROLIGH-PLAMAR APERATURE.	
NOG WPELINE	<b>6.</b> 5′	5.8	89					55			51.8 FT IRON STAINED VUG, APPROXIMATELY 3 CM WIDE.  56.7 FT IRON STAINED VUG, APPROXIMATELY 2 CM WIDE.	AP LP 1800 1 6.3 1.1 50 2 6.2 6.8 34 3 6.3 1.4 6.5 4 6.2 6.5 44 5 6.4 6.9 74 6 6.5 1.6 92
<b>8</b> 9	2.5'	2,5	84					50				
NOGS WPPELL WE	೯೦	6.2	100				<b>59L</b> 0	<b>6</b> 5			65.0 TO 76.0 FT LINESTONE, BROWNISH	,
NOG WRELINE	0.0	10.0	r 100	0.00	1	20 5		70			GRAY(5YR 4/1) TO LIGHT GRAY(NT), HARD, SLIGHTLY WEATHERED TO FRESH, STYLOLITI MASSIVE, CHERT LENSES (UP TO 0.2 FT THICK).  66.0 TO 71.6 FT VUGGY ZONE, VUGS PRIMARILY ASSOCIATED WITH CHERT LENSES	c.
							SOLO	75	1	Ц.	1	



SECURITY OF SECURI	G	EOL	OGIC	DR	ILL L	_0G	•	ROJECT	FUSF	RAP	- WELDON SPRING SITE JOB NO. 14501-201	SET 3	T NO.	HOLE NO. G-9
SBOLD 76 - BOTTON OF BORING AT 76.0 FT. BORING OF BLEACH TO BRE DOWN CLEAR MLD.  ROD-FOCK DUALITY DESIGNATION OF COME PIECE LP-INDREST PIECE OF COME FROM EACH RUM.  ALL SOIL AND ROD COLOR CHART PRINTED BY THE BEOLUGICAL SOCI-ETT PIECE AMERICA. 1946.	AMETER R ADVANCE CORE RUN	RECOVERY	E BLOWS W NT CORE	-	TESTS	<u></u>	ELEVATION	£1.				1	HUTT	ES ON: ER LEVELS,
BOTTOM OF BORING AT 76.0 FT. BORING GROUTED TO SURFACE ON 6/16/86.  BOTTOM OF BORING AT 76.0 FT. BORING GROUTED TO SURFACE ON 6/16/86.  ROD-RDCK DUALITY DESIGNATION FOR FACH RING OF COME FROM EACH RING OF COME FROM EACH RING COLON DESCRIP- TIONS FROM THE BOOK COLON CHART PRINTED BY THE GROUTED AMERICA, 1946.	SAMPLE SAMPLE	SAMPLE	SAUPL	LOSS R R	PRESSURE P.SJ	TAVE N NWAJTES			CRAPH	SA	CONTROL TO THE SELECT RESIDENT		CHA	EACTER OF
BOTTON OF BORING AT 76.0 FT. BORING ORDUID TO SURFACE ON 6/16/86.  ROD-ROCK QUALITY DESIGNATION FOR EACH RUN APPRAGE LEDGY COP COSE FROM EACH RUN.  ALL SOIL AND ROC COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCI- ETY OF AMERICA, 1946.							1			П			1	
SSTSPLIT SPOOK STESKELBY TUBE: SITE MOLE NO.											GROUTED TO SURFACE ON 6/16/86.	IG	ROD =ROD =ROD =ROD =ROD =ROD OF EACH SO COLOR TIONS   GEOLOGETY OF 1948.	ACH TO BREALEAR MUD.  DCK DUALITY ESIGNATION OR EACH RUN ERAGE LENGT CORE PIECE OGEST PIECE CORE FROM CH RUN.  IL AND ROCK DESCRIP- FROM THE DLOR CHART D BY THE ICAL SOCI



	G	EOL	OGIC	DRIL	LL	.0G		FL	ISRAP	- 1	ELDON S	PRINC	SITE	14501	-201	1	<b>y</b> ?	G-13
ΠE		WEST	OF BLD	G. 30	1		COOPDONTES		N9	9,5	21	<b>V</b> 50,	517		MELE	FROM HE	<b>3.</b> C.	E MOG
6/10.	mt.	1	PLETED /12/86	DPLL	DA GE		DLOGY INC.	DAL	I WATE	_	1000. E-45		HOLE SEE	OVERBURE:		MCX F	7J 12.5	TOTAL DEPTH
		THE I		COPE	BOKES	SMPLE		FCASAG		ouro		ם אורם	-	D	<u>,                                     </u>	1	D. TOP 0	ROCK
		18/72	BIT /F ALL	1_	4	5	H HOLE DAVA	-		654	LOSOED BY		31.081/623	1.62	•	1	28.51/	626.2
		LBS/					NONE							LAURENCE	YOUN	G		
AND DAMETER	DETH COTE RATE	CORE RECOVERY	SAMPLE BLOWS  W PRECENT CONE RECOVERY		MATER MESSIAE TEXTS	74.K # # #OUTES	ELEVATION	<b>ВЕ</b> РТИ	CHAPTE LOG	SAPLE	•	ieschp ti	ON AND CLASS	FEATIN			98.7 98.7 98.7 88.6	EE COO BY LEVELS, BY RETURN PACTER OF LINE FTC.
SS 2*	18*	10°		<b>S C</b>	3	6	654.7	0		1	(5YR 4/	1) TO 1	SILTY <u>CLA</u> MEDIUM GR TO STIFF,	AY(N5),	MO1ST	,	FOR 2	5 F7 DRILLI 51/41N OD H TEM AUGERS CENTER PLI
SS.								5									BOREH RAD10 LOGGE EBERL	INE
S	18*	18°	13	3	5	9		<u> </u>		3							CORPO	TICAL RATI <b>O</b> N.
							637.7	15			(N5), M	0151.	FT SILTY STIFF, TR	TACE TO S	SONE !	SUB-	REFUS 28.5	FT AUGER AL. TO 71.0 F ED WITH NO
2*	18*	21*	16	4	8	8	<b>63</b> 2.7	20			GRAINED LUSITE	SAND, STRING		ZONES,	PYRO	•	VIREL IMPRE BIT L	INE DIAMO GNATED CO ISING WATER LEAR MUD.
55 2'	18"	18*	35	5	15	20		25		5	YELLOW!	SH OR	FT GRAVE ANGE(10YR T GRAVEL, INE-GRAIN	6/6), M	DIST.	HARD,		FT COMPLE LOSS.
							<b>626.</b> 2	28.5					FT LINES				BLRL 1	NGTON/KEO
IRE INE ORE	1.0	3.8	54	14.9 16.5 18.7 16.3	10 20	15 6 6 5	619.7	30		RW •]	ISH BRO MODERAT AND SAU PLANAR	MM(10' TELY W D FILI APERA' THICK	OYR 6/6) YR 5/4), EATHERED, LED FRACT TURES, CH , VUGGY,	NODERATE HORIZON URES WIT ERT LENS	LY NA ITAL D 'H SMO ES UP	MD, Lay Xoth-		6/12/86 <u>801 +1</u> 860 + 65x P + 8.3 FT P + 8.7 FT
	j .	l .	1	, , -, -	,		1 10 14 1										1	



le	G	EOL			DRIL	BATER			NOLECT	FUSF	WP	- WELDON SPRING SITE M501-201 2	# 2 G-13
0.0 Over 10.0	HENCTH CONE IN	CONTRACTOR IN	SAMPLE BLOWS	MECONERY	17 (7) 11 (10)	MESTS IN INC.	TME PH MME/TES	ELEVATION	75 25	<b>SERVICE 108</b>	SHOTE	MESCRIPTION AND CLARSFICATION	MATER LEVELS, BATER LEVELS, BATER RETAINS, DOMACTER OF MILLINA, ETC.
XS.		1.8'	36						40		FRUM 02	29.8 TO 31.0 FT CAVITY FILLED WITH MODERATE BROWN(5YR 3/4) CLAY AND ANGULAR CHERT GRAVEL, APERATURE DRIENTED 70° RELATIVE TO CORE AXIS.	
IXB IRE INE ORE	0. 8	6.2	62	•					45		RUN 63	40.8 TO 41.3 FT HORIZONTAL FRACTURE FILLED WITH MODERATE BROWN(5YR 3/4) MEDIUM GRAINED SAND AND TRACE OF ANGULAR CHERT GRAVEL. 44.0 TO 47.0 FT CAVITY FILLED WITH MODERATE BROWN(5YR 3/4) CLAY AND SOME ANGULAR CHERT GRAVEL.	AP LP R00 Rate (FT) (FT) (Z) 2 8.4 8.4 45 3 8.3 8.6 42 4 8.2 8.5 35 5 8.2 8.4 35 6 8.5 1.0 75 7 8.6 2.4 70
ORE		4.2	-						55		S RUN 64		
NXB		8.0						591.9	60 62.0 65	盐		62.8 TO 71.0 FT LINESTONE, BROWNISH GRAY(5YR 4/1), MODERATELY HARD, SLIGHTLY MEATHERED, MASSIVE CHERT LEMSES UP TO 0.2 FT THICK, SMALL VUGS (2 MM+) IN	AP-AVERAGE LENGTI OF CORE PIECE
NXB FIRE INE CORE	5.0	5.6	31	00				583.7	70 71			CHERT LENSES, NO APPARENT FRACTURES.  BOTTOM OF BORING AT 71.0 FT. BORING GROUTED TO SURFACE ON 6/12/86.	LP=LONGEST PIECE OF CORE FROM EACH RUN.  ALL SOIL AND ROC COLOR DESCRIP- TIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCI- ETY OF AMERICA BAR
					SHELDY TO			SITE		1_	1	WEST OF BLDG. 301	HOLE IID.



_													J		DEET I		HELE HO.
	GE	OL	OGIC	DRIL	LL			FUSR	AP -	METDON	SPRING SIT	rE	1450	-201		<b>3</b>	G-14
TE		SOUT	H OF BL	DG. 41	17		COORCINATES		N99,		¥49, 935				90		•
6/6	/86		111ED 100/86	DOLLE	CE (	TECHNI KURT	LDGY INC.	DPEL M		10 11000. ME-45		/4°/3°	37.		, ,	1.9	TOTAL DEPTH
		6/92	70	COPE	BOKES	SMPLE	D. 100 0	CASSIC	l.	0 EL. 55.8	EPTIVEL OF	40'/6H			MPTIM	37.5'/	
	-	0 10	DIT /FALL		•	E 1171 8	HOLE DA.A.I	D&TH		LOSSED I	7.		LAWRENCE	YOUN	G.		
AND DRAKETER	COUNTY ONE WAY	CONT. MODILE CONT.	SOUTH HORSE	F	BATER MESSAGE TESTS	<b>9</b>	ELEVATER	MEPTH MAPPEL LOS	Thems		BESCHPTION A	E CLAS				EM.	PES COM PER LEVELS, PER PET LEVE, MALETER OF
18		3 8		S= 3	7	A = 2	655.8	8									LING, ETC.
							655.3	0.5		0.5 TO ISH OR	.5 FT GRAV YASH MATR 17.0 FT S ANGE (10YR TIFF, MOTT	IX. R	DAD BED. CLAY, DAI MOIST,	RK YEI	LOW- TO	WITH S	5 FT DRILLE 61/41N OD HO TEM AUGERS CENTER PLU
SS 2'	18*	12*	15	7	8	7		5		(NB) S	ILT LENSES	, 1R0	N STAINE	D <b>NO</b> DI	LES.		·
\$\$ 2*	18*	17*	9	2	4	5		10								BOREH RADIO LOGGE EBERL ANAL	
\$\$ 2'	18*	16*	19	3	7	12		15 1		<b>3</b>						CON	KKI JUN
**	_						638.8	17		MISH (	TO 27.5 FT DRANGE (10Y SOME GRA	R 6/6	), MOIST	, VERY	1		
\$\$ 2*	18"	21*	26	7	12	14		20		SAND,	PYROLUSIT	E STR	ingers.				
\$\$ 2*	18*	23*	29	14	15	14		25		5							
\$\$ 2'	18'	0*	56	40	38	18	628.3	27.5		- LIGHT	TD 37.5 F1 GRAY(N8) 5/6), MD1	TO DA	PK YELLO	WISH	ORANGE	Y	
\$\$.	1	-	-	22	+-	+	1	30		WEATH	ERED CHER	T GRAV	ÆL.				
	+		1	1	1		1	🐉									
\$\$ 2	18	11'	32	3	14		620.8	35		8						MALE	
			900m 57#				<b>E</b> LIF	S	DUTH	OF BLDO	. 417 ON	PERIME	TER ROAL	)			G-14



	G	EOI	OGIC	DRI	LLL	.0G	ľ	NOLECT		WP	- WELDON SPRING SITE	M50F20I 2	er 3	MQ.E	16. G-14
	THE MOVEMENT	RECOVERY RECOVERY	TIC BLOWS		BATER PESSUE TESTS	1	ELEVATION	1	MANE LOS	SAPPLE	BESCHPTION AND CLASSIFIE	CATION		OTES ON ATER LET ATER RET	TURN.
3 8		36	S E	S= 3	PESSER 2.5	3 - 5	520.3	35	1					MAACTE Maain, E	
		0.1					618.3	57.5		2 1 2	37.5 TO 57.2 FT <u>Linesto</u> Wish Orange(10YR 6/4), S		DRIL VIRE	LED WI	TH NOS CORE BI H WATE
NXB	2.1'	1.8	86	 				40	臣	AC.	MODERATELY WEATHERED, MC TO HARD, CHERT LENSES UP	DERATELY HARD	FM.	•	ı/KE <b>O</b> KU
NXB	5.0'	4.6	92							RLM •3	THICK, VUGS UP TO 3 CM N TALLY FRACTURED WITH ROL APERATURES AND IRON STAI FILLING. 38.3 TO 38.8 FT HORIZON	IGH PLANAR HHING AND CLAY TAL FRACTURE,		6/9/I FT CC R LOSS	MPLETE
NXB	9.0'	7.7	86					50		FUN OF	ROUGH PLANAR APERATURE, MEDIUM LIGHT GRAY(N6) CI		1 2 3 4 5 6 7 8	9.1 9.2 9.3 9.4	LP RCC FT) (X 0.1 0 0.5 27 0.6 50 1.3 0 0.3 0 0.2 0 0.8 54 2.0 70
		0.7	<b>†</b>					<b>5</b> 5		S Beenly	·				
NXB	10.1	10.1	100				598.6	57.2 <b>6</b> 0		NW +7	57.2 TO 69.8 FT LIMESTO GRAY(5YR 4/1), HARD, SL INTERBEDDED WITH GRAYIS MEDIUM DARK GRAY (N4) S	IGHTLY WEATHERED H BLACK(N2) TO			
NXS	9. 9	9.9	100	0 0 0 0 0	10 20 30 20	10 10 10 5	586.0	<b>6</b> 5 <b>6</b> 9. 170			69.8 TO 76.4 FT LINESTO (N7), MARD, SLIGHTLY WE STYLDLITIC, CHERT NODUL IN CHERT NODULES.	ATHERED, MASSIVE			
							580.8	75			AN WENT MANEES				
			PODY STA				SITE		SOL	ЛН	OF BLDG. 417 ON PERIMETE	r ROAD	HOLE		G-14



HOLE NO. SEET NO. JOB NO. PROJECT GEOLOGIC DRILL LOG G-14 3 or 3 14501-201 FUSRAP - WELDON SPRING SITE WATER SAMPLE BLOWEN
SAMPLE BLOWEN
SAMPLE BLOWE
W
PERCENT COME
RECOVERY NOTES ON PRESSURE WATER LEVELS. TESTS SAMPLE FF 130 WATER RETURN DESCRIPTION AND CLASSIFICATION ELEVATION CHARACTER OF DRILLING ETC. 580.8 76.4 579.4 SINGLE BX PACKER BOTTOM OF BORING AT 76.4 FT. BORING LOST IN HOLE AND GROUTED TO SURFACE ON 6/10/86. GROUTED IN. ROD=ROCK QUALITY DESIGNATION FOR EACH RUN. AP-AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIP-TIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SDC!-ETY OF AMERICA, 1948. HOLE NO. STE G-14 SS=SPLIT SPOON; ST=SHELBY TUBE; D=DEDNASON; P=PITCHER; C=OTHER SOUTH OF BLDG. 417 ON PERIMETER ROAD



	G	EOL	OGIO	DF	ILL	LO	G	וופטנים		٠.	WELDON SPRING	SITE	14501	-201	SHEET NO	r 3	G-15
	AST		aff inat				COOPDIMATES			98,			OVE RELEGE		90		TOTAL DEPTH
an 6/5	/ <b>8</b> 6	1	LETED /12/86	DRILL	ER GE	KURT	OLDGY INC. JAEGER	`		CI	ND NODEL E-45	6-1/4*/3	· 41.		34	4.5	75.5'
K I		.3/8°		CORE	BOXES 4	SAPLE 8	S EL. 10P	Q (7	SINC S		8.D	18.10'/		•	BEF187E		0F ROCK /617.0
M.			1917 FALI		EAS1	NS LEFT	IN NOLE : DI	A. Æ	METH		LOGGED BY:		LAWRENCE	YOUN	iG		
5	<b>813</b>	T			MATER RESSURE				8		,						ES ON! ER LEVELS,
AND DIAMETER	LENGTH COME N	SAMPLE RECOVERY CORE RECOVERY	"N" "N" PERCENT CORE		TESTS	INE IN NUTES	ELEVATION	ME 720	HAPHIC LOC	143	BESCRIP	IJOH AND CL	ASSIF ICATIO	<b>X</b>		DU	ER RETURN, RACTER OF
3	35	SAMP		151 E	Mark SS	11 M	<b>6</b> 58. 0	0	8							DAI	LLING, ETC.
									1//		0 TO 8.0 FT S	ILTY <u>CLA</u>	BROWN!	SH BL	.ACK		) F7 DRILLED -1/4° 00 HOL-
									<b>Y</b> //		DEBRIS, SOME						TEM AUGERS CENTER PLUC
Ş	18°	10.	12	4	5	7			<b>\</b> //	H							
-	,,,	.0	16	-	-	<u>'</u>		5 -	<b>\//</b>								
				,					<b>¥</b> //								
							650.0 649.5	8.5			8.0 70 8.5 F			CK (N1			10.0 FT DLE WAS
\$\$ 2 <b>•</b>	18"	11,	9	2	3	6		10 -	<b>3</b> //	2	ORGANIC DEBR 8.5 TO 17.0			DWN1SI		RADIO LOGGE	L <b>OGICALLY</b> D BY
									1//		GRAY (5YR 4/1 BROWN (5YR 5/	TO MODE	RATE YEL	OM] 21	н	EBERL ANAL Y	INE
									1//		LENSES OF LI				·		RATION.
\$\$ 2'	18*	18'	9	3	4	5			<b>*//</b>	3							
7						ļ		15	1//	7							
							641.0	17	¥//		17.0 TO 31.5	FT SILTY	CLAY, M	ODERA	TE	<u>Ā</u> 6.	/6/86
55		_	ļ			<u> </u>	-		1//	4	YELLOWISH BR	OWN ( ) OYR	5/4), MO	151,	STIFF		
\$\$ 2*	16.	18*	13	6	6	7	-	20	<i>\\\\\</i>	7	GRAVEL, AND	PYROLUS]]	E VEINS,	TRAC	E ·		
									<b>*//</b>							INIT	ALLY FOLE WAS
							]		<b>1</b> //	1						LOGGE	D THROUGH DW STEN
\$5 2'	18*	18*	21	6	9	12		25	<b>1//</b>	15						AUGER	RS. AFTER LETION OF
									\$//							HOLE	, 4-INCH PVC INSTALLED AN
									¥//							BORE	HOLE WAS GGED.
SS 2	18'	24"	21	6	10	11	1		1//	16	1					ותבנט	99LU.
2.	<del>                                     </del>	<del>  -                                   </del>	-	+	+ "	+	1	30	1//	7	1						
							626.5	31.	5	8	31.5 TO 37.	FT SILT	Y CLAY,	ODER/	ATE	1	
**	-	-		-	_	-	-		1//	1	YELLOWISH BI	KUWA (10YR	5/4), M	,151			
% ??	18	25	18	6	8	10	623.0	35	1//	1						HOLE I	<b>r</b> c.
			SPOON; S				\$1TE			EA	ST OF RAFFINA	E PIT NO	. 2				G-15

A-32



	G	EOL	.OGIC	DRI		-06			FUSF	RAP	- WELDON SPRING SITE   14501-201   2 o	F 3 G-15
LE TER	LENGTH COPE PLIN	COVERY	SAMPLE REOWS  "Y"  PERCENT CORE  RECOVERY		WATER PRESSURE TESTS	E	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN
AND DIAMETER	E CHICTH	SAMPLE RECOVERY COME RECOVERY	SAMPLE	C.P.N.	PRESSURE P.S.J	TAME	623.0	35	S S	2		OMRACTER OF BRILLING, ETC.
							<b>621.</b> 0	37			37.0 TO 41.0 FT GRAVELLY CLAY, DARK	
s			67+	-	17	50/5*				8	YELLOWISH ORANGE(10YR 6/6), MOIST, VERY STIFF, GRAVEL IS MODERATELY	
Ş	18'	19'	614	9	17	30/3	617.0	40 <b>-</b>			41.0 TO 70.7 FT LIMESTONE, DARK YELLOW-	41.0 TO 43.0 FT DRILLED WITH
					-	F		-		1	MODERATELY MEATHERED, MEDIUM SOFT TO MEDIUM HARD, HORIZONTALLY FRACTURED	2-7/B INCH TRICO ROLLER BIT. 43.0 TO 75.5 FT
#111 C 111C					-			45 -		-	UP TO 0.3 FT IN THICKNESS.	DRILLED WITH NXB WIRELINE CORE BI
DYN.	7.5	4.45	57									AP LP ROD RUN (FT) (FT) (Z.)
				_				50 -				1 0.4 1.3 76 2 0.5 0.8 83 3 0.3 0.8 69 4 NA NA NA 5 0.6 1.2 83 6 0.4 0.9 75
מאמ		1.5	<del>                                     </del>	1.5	10	6			事			6 0.4 0.9 75 7 0.5 1.4 65 8 1.0 1.6 97
XE.	2.0°	C. 4		2.0 2.4 2.0	20 30 20	7 8 5					54.0 TO 54.4 FT SAND FILLED FRACTURE, HORIZONTAL FRACTURE WITH ROUGH PLANAR	
	1.5	1.5	100	1.5	10	5	-	<b>5</b> 5	丰		APERATURE. SAND IS DARK YELLOWISH DRANGE(1DYR 6/6), MEDIUM-GRAINED, WITH	
XB WIRELINE	5.5	4.7	85								CHERT GRAVEL: 55.5 TO 61.0 FT HEALED FRACTURES	
<u>.</u>		-	-					60		디 다	6:.0 TO 70.5 FT THIN GRAYISH BLACK	
									井		(N2) SHALE INTERBEDS.	
WIREL INE	9.5	5 9.	5 100					65	甚		(	
NXB M										TÍ T	ξ	
								70	抽井	HH		
WIREL INE	5.0	0 4.	9 98				587.3	70.	11	TI'	70.5 TO 75.5 FT <u>LIMESTONE</u> , MEDIUM LIGHT GRAY(N6), WITH CHERT NODULES, DCCASIONAL STYLOLITES.	
ž	1_	<u> </u>	SPOON; ST				583. 0	75		#	EAST OF RAFFINATE PIT ND. 2	HOLE NO.



				HOLE HO.
GEOLOGIC	DRILL LOG	FUSR	RAP - WELDON SPRING SITE M501-201 3 or 3	
MARLE RECORDS  AMELE RECORDS  CORE RECORDS  CORE RECORDS  VALUE RICHE  WHENESTE CORE  RECORDS	BATER PRESSURE TESTS SLEVE	THORN 25.3	SCHOOL WE CLASHFOLTON	MATER CIN MATER LEVELS, MATER RETURN, CHARACTER OF
M SAMPLE TO THE	25 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	1 1 1		BRLLOG, ETC.
			GROUTED TO SURFACE ON 6/12/06.	MILE NX PACKER ST IN HOLE AND OUTED IN. D-ROCK QUALITY DESIGNATION FOR EACH RUN. PAVERAGE LENGTH OF CORE PIECES OF CORE FROM EACH RUN.  LL SOIL AND ROCK OLOR DESCRIP- IONS FROM THE OCK COLOR CHART RINTED BY THE EOLOGICAL SOCI- TY OF AMERICA, MB.
SE-SPLIT SPOON STO S-GEOGRAPH P-PTTD			EAST OF RAFFINATE PIT NO. 2	G-5



GEOLOGIC DRILL LOG PROJECT FUSRAP - WELDON SPRING SITE 14501-201 1 - 3 C-16 3 COORDONATES FIELD ADJACENT TO ARMY PROPERTY N98, 051 **V51,007** 10 MOUN COMPLETED DALL MAKE AND MEDEL GEOTECHNOLOGY INC HELL SHEE M 77 TOTAL BEPTE 6/3/86 6/5/86 CME-45 KURT JAEGER 6-141/3 340 46.4 80.4 COME RECOVERTE 1\_/20 COME BOXES SAMPLES EL TOP OF CASAG GROUND EL. PINEL PRIME MITTER PTEVEL TOP OF MICK 35.8/17 656.7 301/626.6 34.0 /622.7 SAIPLE MANER BUBIT/FALL CASHIC LEFT IN HOLE DILLALDICTH 140 LBS/30 N NONE LABRENCE YOUNG BATER SAME DE ANTANG LIDETH CORE RAN SAME RECONDITY SAMPLE BLOOTS

WENGENT COME MESSURE MITTELS ON TESTS MATER LEVELS, ELEVATION RESOURTED MED CLASSIFICATION È Ā = 2 2 CHARACTER OF 8=2 BLLDG. ETC. 656.7 0 .5 0 TO 0.5 FT SILTY CLAY, BLACK(NI). 656.2 0-34.0 FT DRILLED ORGANIC DEBRIS. TOPSOIL WITH SHIN CO ROL-0.5 TO 12.5 FT SILTY CLAY, MODERATE LOW STEM AUGERS. YELLOWISH BROWN(10YR 5/4), MOIST, VERY STIFF, WITH MEDIUM LIGHT GRAY SILT 18. 12 17 5 6 11 LENSES, AND LENSES OF BLACK(N)) ORGANIC DEBRIS. 5 18' 11 17 7 10 10 0 TO 10.0 FT BOREHOLE WAS RADIOLOGICALLY 644.2 12.5 LOCCED BY 12.5 TO 21.0 FT SILTY CLAY, BROWNISH EBERLINE GRAY(5YR 4/1), MOIST, VERY STIFF, TRACE ANALYTICAL 12' 18" 20 5 8 12 TO SOME GRAVEL, TRACE FINE-GRAINED SAND, CORPORATION. 15 OXIDIZED NODULES. 18" 14 5 15 6 9 20 21 635.7 21.0 TO 34.0 FT GRAVELLY CLAY, VERY LIGHT GRAY(NB), STIFF, MOIST, WITH SLIGHTLY WEATHERED, CHERT GRAVEL. 4 16. 734 22 23 50/4 29.0 TO 34.0 FT 25 FALLING HEAD PERSEABILITY TEST 10 18. 34 14 13 21 34.0 FT AUGER REFUSAL 1/2 0 50+ 50/1/2 BURL INCTON/KEOKUK **6**22.7 FN, 34.0 TO 71.9 FT LINESTONE, MODERATE YELLOWISH 621.7 401 100 SS-SPLIT SPOOK ST-SHELBY TUBE DIDENSION PAPER DESTREE FIELD ADJACENT TO ARMY PROPERTY G-16



	G	EOL	OGIC	DRII	LL	.0G	F	ROJECT	FUSR	AP	- WELDON SPRING SITE	JOB NO. 14501-201	2	NO. OF 3	HOLE NO.	<u>.                                    </u>
AND DIMETER	LENGTY COPE PLIN	SAMPLE RECOVERY	SAMPLE BLOWS "W" PERCENT COME PECOVENY	LOSS N	WATER MESSURE TESTS 380353384	TME IN MMUTES	ELEVATION	¥-00	GRAPHIC LOG	SAMPLE	description and classifica	TION	-	¥/	ITES ON: LITER LEVELS LITER RETURN MRACTER OF BLLDIG, ETC.	L
$\dashv$	-	<b>V</b> 1			£	2	62L7	35	1,1	-	BROWN(10YR 5/4) TO MEDIUM	GRAY(N5).		34.0	- 34.5	FT
XB XRE	5.0	1.0	20							RUN +1	SEVERELY TO MODERATELY WE MEDIUM SOFT TO MEDIUM HAR HORIZONTALLY FRACTURED WI STAINING ON FRACTURE SURFLAYERS AND LENSES RANGING	ATHERED, D, VUGGY, TH IRON ACES, CHER	T	DRILI ROLLI STAR 34.5	ED WITH R BIT T COREHO - 80.4 ED WITH	O LE.
XB XRE	1.5	0.7	47					40 -		R*2	FROM 0.5 TO LESS THAN 0.1			WIRE	INE BIT	
XB ORE	5, 5	5.5	100		,	-				RUN +3					FT COMP	LETE
								45 -	臣		46.5 TO 56.5 FT ANGULAR (	CUEDY EDACA	FNTC	WAIE	K LU33.	
				13.4 15.3 16.8	10	15					AND INTERBEDS OF GREENISH TO GRAYISH OLIVE GREEN(S)	GRAYISG 6	5/1)			
				10.0	20	'		50 -						N/ N/	AP LP	, Ro
XB PRE	10.0	8.9	89							AUN •				RUN 1254567	0.1 0.3	_ 43
								<b>5</b> 5 ·			56.5 TO 60.5 FT MODERATE	LY WEATHER	ED,	9	1.0556 0.566 0.566 1.0	52 70 87
XB ORE	4.1	4.0	98							RIN #5	I NODULES.	K) CHERT				
		-						60		-						
DRE	2.0	2.0	100							R						
IXB OR£	8.0	3.4	43					65								
IXB ORE	1.5	1.4	93	-				70	川川							
NXB ORE		8.9					584.8	71.9	异		71.9 TO 80.4 FT LIMESTON GRAY(NG), SLIGHTLY WEATH MASSIVE. WITH LIGHT GRAY	ERED, HARD	RT			
URE							581.7	75	臣		NODULES, BROWNISH GRAY(S	SYR 4/1) TH	IN			
							SITE		ŗ	]F	LD ADJACENT TO ARMY PROPER			HOLE	NO. G-1	6



	G	EOL	OG	IC	DRI	LLI	.0G	F	O.ECT	FUSF	WP.	- WELDON SPRING SITE MEDI-201 3	D. G-16
MO DAMETER	SAMPLER ADVANCE.	RECOVERY RECOVERY	SAMPLE BLOWS	OVERY		WATER MESSLIPI MESSIS	1	ELEVATION	11.00 11.00	CHAPTEC LOG	SAMPLE	BESCHPTION AND CLASSIFICATION	METER ON MATER LEVELS, MATER RETURN, CRARACTER OF
18	SAME LE	MODEN 3400	375		76.70 10.53	18.5 19.7	F = 2	581.7	75	ğ			BELLING ETC.
									80. 80.			BOTTOM OF BORING AT 80.4 FT. BORING GROUTED TO SURFACE ON 6/5/96.	APPROXIMATELY 20FT OF 1-1/4* PVC PIPE GROUTED IN HOLE.
										**************************************			ROD-ROCK GLIALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECE OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCI- ETY OF AMERICA 1948.
					DELEY TO			STL	1_		 F 16	ELD ADJACENT TO ARMY PROPERTY	MALE IN.



ī E	GI	OL	OGIC	DRIL	LL	OG	COORDONATES	DJECT F	USRAI	٠.	WELDON S	PRING	SITE	14501	-201	PRES H	<b>#</b> 3	HOLE NO. G-18 MEANIC
		COL	D, N W PLITED /23/86	DALL	TR GE	OTECHN	OLOGY INC	•	LL WN	U M	, 350 D MODEL J/CME 750		,551 HOLE SAX 6-1/47/37	0404814801 36.0	<b>617</b>	90 100x 6		- 1914 MFTR 79.0
	NA.	8/88 ER BE			BOKES 5	SAPLE 3	NONE	DF CASD	G O		13.8 LOGGED BY		4LO'/59		/AATRI	<u> </u>	36.0°/	
AND DAMETER	SAMPLES ADVANCE	CONE RECOVERY	SAMPLE BLOWS TO THE COME	F	BATER MESSAPE TESTS	<b>1 2</b>	D.EVATION	11.C3	PRAFIE LOS	SHORE	!	BESCH TI	PI AND CLAS	SFICATION			GM.	ES ON EN LEVELS, EN RETURN, RACTER OF LING, ETC.
-	315	38	2 15	5×3	25	30 1	633.8	0	•		0 70 5.	O FT C	LAYEY SI	T, MODER	ATE		0-17.5	FT DRILLE
						-					YELLOWI	SH BRO	WN(   QYR	5/4), DRY STIFF TO	, SOM		TOM 2.	V41N 00 HO TEM AUGERS CENTER PLU
Ş	18"	13*	21	4	13	14	628.8	5 -		1				CLAY, DA				
											STIFF T	O VERY	STIFF,	6/6), NO SOME FINE USITE VE	CRAN	VEL.	BOREH	10.0 FT OLE WAS LOGICALLY
\$ ?*	18*	14"	12	3	5	7		10 -		2							EBERL ANAL Y	INE
\$ ?	18"	17'	19	3	9	10		15 -		3								
							616.3	17.5									REFUS	
								20 -	4								17.5 US1M	EB FROM TO 36.0 TRICONE ER BIT - NO
<b>XE BIT</b>									1				•					.e recovery
2-7/8" TRICONE								25	1									
7-2									1									
								30	4								WATE	R LOST AT 2
									4									
							598.8	35	1								HOLE I	
			9700% \$74 0% PHP11 DH				<b>S</b> TE		F	PATE	OL ROAD,	NWC	ORNER OF	SITE				G-18



	Gl	<u>:</u> 0l	<u> </u>	<u>الر</u>	DRIL		.06		Γ .	FUSF	RAP	- WELDON SPRING SITE 14501-201 2	pr 3 G-18
NO DIMETER	LENGTH COPE PLAN	E RECOVERY RECOVERY	SAMPLE BLOWS	PENCENT CONE. Recovery		WATER RESSURE TESTS		ELEVATION	9EP 134	GRAMME LOC	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN. CHARACTER OF
2	35	TON S	SAM	E E	Σε π. π. 14.	PRESSURE P.S.I	THE	<b>598.</b> 8	35	6			DRILLING ETC.
_			-					597.8	36		-	36.0 TO 71.7 FT LIMESTONE, MODERATELY WEATHERED, BEIGE TO YELLOW	BURL INGTON/KEOKUK
					18.1	10	5					LIMESTONE W/ DCCASIONAL GRAY ZONES, MODERATELY TO HIGHLY FRACTURED, LOCALLY	1174
	7.0'	4.0		57	20.4	20	5		40 -	丰		EXTREMELY FRACTURED, LOCAL DISSOLUTION. LIMESTONE IS SOFT TO MODERATELY HARD,	<b>—</b>
					17.0	10	5			宝	4_	CHERT IS HARD TO VERY HARD. OCCASIONAL CALCITE FILLED VUCS. BECOMES FRESHER,	6/23/86
			-									LESS FRACTURED BELOW 64 FT, STYLOLITES BELOW 64 FT.	
				•					45	基		•	
	6.0'	4.7		7 B						基			AP LP RC
10											I I		RUN (FT) (FT) () 1 0.2 0.45 3 2 0.2 0.7 4
UIAMONU									50	#	IJ IJ <sub>z</sub>		3 0.2 0.5 3 4 0.3 0.8 7 5 0.3 0.7 5 6 0.3 1.2 6
	4.0'	3. 4	,	85						五	I Z		
BARREL		-								坦	H-H		
CORE	6.0			100					<b>5</b> 5	莊	T S	•	
WIRELINE C	6.0	0.1								+			
	-	-	-		-					H			
NXB NXB									60	田			
										基	╣,		
	10.0	9.	9'	99					65	主		NOW THE PROPERTY OF THE PROPER	
									6.	, <del>II</del>			
										五			
	-	+	+		-				71	耳。	丑		
								562.1	71	.;		71.7 TO 79.0 FT LIMESTONE, GRAY, CRYSTALLINE, IRREGULAR OCCURENCES OF	
	10	0'10	. 0'	100								GRAY CHERT, FOSSILIFEROUS, SLIGHTLY WEATHERED TO FRESH, HARD LIMESTONE AND AND VERY HARD CHERT, SLIGHTLY TO	
								558.8	7	5 #		MODERATELY FRACTURED, MOST ARE	HOLE NO.
					SHELBY EPG D= OTI						P	ATROL ROAD N W CORNER OF SITE	G-18



G	EOL	OGIC	DRI	LL	.0G		OLECT	FUSF	WP		ED. HELE IN. G-IS
AND UNKERNAME MANUTAL CONE NUM	RECOVERY RECOVERY	SAULE BLOWS  W  W  W  W  W  W  W  W  W  W  W  W		TESTS		ELEVATION	N. GE	PAPHEC LIBE	SAMPLE	BESCHPTISH AND CLASSFICATION	METES ON OLIDE LEVELS, OLIDE RETURN, CONNECTES OF
SAME OF ANY	38	3 5	E = 3	7.50 E	A = 2	SSALB	75				BRALING, ETC.
						<del>55</del> 4. \$	79			NEARLY HORIZONTAL. PRESSURE SOLUTION ACCUMULATES OF SOFT TO MODERATELY SOFT DARK GREEN TO BLACK MATERIAL AT 77.5 TO 77.4 FT, 78.0 FT, 78.2 TO 78.3 FT, AND 78.5 FT.	
								<del></del>		BOTTON OF BORING AT 79.0 FT. BORING GROUTED TO SURFACE ON 6/23/86.  ROD=ROCK GUALITY DESIGNATION FOR EACH RUN. AP=AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN.	ALL SOIL AND ROCCOLOR DESCRIP- TIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCI- ETY OF AMERICA, 1948.
		9700% 514 0% P=FTI D				STIL.		1	1	ATROL ROAD N W COPMER OF SITE	WELT NO.



	G	EOL	OGIC	DRIL	LL	OG	P	ROJECT F	USRAP	_	WELDON S	SPRING	SITE	JOB HC. 14501		1	of 2	HOLE NO. G-19
TE	NODI	ם סבנ	RIMETER	PATRO	ROAD		COORDINATES	<u> </u>	N.	101.	700	<b>V</b> 51	<b>. 9</b> 50		ANGLE	FROM H		BEARING -
CUN		COM	PLETED	DRILL	ER (	GEOTEC	HNOL OGY	1	LL MAK	E ANK	MODEL		HOLE SEE	OVERBURDEN		ROCK O	FTJ 24.5	TOTAL DEPTH
/19.	/86 ECDVE	_1.	/29/86 /20		BOXES	ER/GEC	RGE MATTI	HEWS		-45	/CME-750	1	6-1/4'/3'	4L5			TOP C	FROCK
	20	.5/82			3	9	N HOLE: DIA /1	- CMCTH		619	LOGGED BY		40.5′/5	78.9	<del></del>	<u> </u>	4L5'/	577.9
		_	/30 IN		LASA	K QD I I	NONE	E-NO IN					LAWRE	NCE YOUNG	EBER	GLUND		
AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SANPLE BLOWS  "W"  PERCENT CORE  RECOVERY	F	WATER RESSURE TESTS	23	ELEVATION	DEP 114	CRAPHIC LOG	SAMPLE	ı	DESCRIP TI	ON AND CLAS	SEFICATION			CHI AV.	TES ONE TER LEVELS, TER RETURN, URACTER OF
ş	SAMPLE	CORE	SAM	1085 1085	PPRESSURE P.S.I	TAKE N IN	619.4	0	8								DAN	LLING, ETC.
				B7 6'	2940 6.	<b>370 6</b> °	618.9	1			WITH BL ROADBED D.5 TO	ACK(N1 18.8 F	) FLYASH T SILTY	IGHT GRAY MATRIX, CLAY, DAR	DRY,		WITH 6	5 FT DRILLE 5-1/4" OD HOL TEM AUGERS CENTER PLU
S.	18*	6*	7	3	3	4		5 1			MEDIUM MEDIUM	GRAY(N STIFF	5) SILT TO HARD,	MOTTLED LENSES, M TRACE TO RINGERS A	1015T, 1 <b>50M</b> E			
57	2'	2'	PUSHE	D <b>e</b> 90	0 PSI			1111		2	OXIDIZE			MINGERS #	¥L	,		
Ş	18*	9"	37	7	17	20		10		3								
Ş	18"	16'	30	4	13	17		15 -		4			·				BOREH RADIO LOGGE EBERL ANALY	
S	3.	0	50+	50/3*			600.6	18.B			LIMESTO (10R 4) SILTY (	ONE, MO 76) TO CLAY, (	DERATE I MODERATI CHERT GR	ELLY <u>CLAY</u> REDDISH BE BROWN(5' AVEL, MOIL DCCASIONAL	ROWN YR 3/ St to	4) WET,		
SS 2'	1.	0	50+	50/1				25 -		6		NT CHE		RS, WITH				
\$\$ ? <b>'</b>	18"	14"	22	26	11	11		30 -		7								
SS 2'	18*	8.	46	9	12	34	584.4	36		8								
	<u> </u>	<u> </u>	POOK STES	HELBY TU	.l .ee:	1 1	TE STE	1 22	17.2	AIO C	TU DED!		PATROL R	DAD			HOLE N	G-19



	G	EOL EE	S E		BATER RESEARCE TESTS	.0G		NO.ECT	FUSA		- WELDON SPRING SITE M501-201 2	67 2 6-19
200 OW	NO HISHIT!	CONFICTION STORY	MODELLE MARI	1055	PACSUM P.C	\$345 <b>00</b> 10 3004	ELEVATION  SOAL 4	35	BANK I	3 Laws	BESCRIPTION AND CLASSIFICATION	BATER RETAINS CHARLES OF STALLISS, ETC.
<u>ಜ</u>	18*	8.	1	17 PAC	1 KER TI	e ST	577.9	40 -		9	39.5 TO 40.0 FT CAVITY.	6/24/86
3°	₿' -	4.5'	56%	17.5 20.0 17.4	10 20 10	5 5 5		45		FLIN O.	41.5 TO 49.2 FT LIMESTONE, DUSKY YELLOW (5Y 6/4), MODERATELY WEATHERED, MODERATELY HARD, MODERATELY FRACTURED WITH HORIZONTAL FRACTURES, WITH LIGHT GRAY (N7), HARD, CHERT INTERBEDS, FILLED VOIDS, AND NODULES UP TO 4 INCHES IN DIAMETER. FRACTURES FILLED WITH MODERATE YELLOWISH BROWN (10YR 5/4) CLAY. FEW OPEN VOIDS 1/4TO 1/2INCH IN DIAMETER.	ALGER REFUSAL AT 41.5' BURLINGTON/KEOKUS FN. 41.5 TO 66.0 FT CORED WITH NOB WIRELINE DIAMOND INFREGNATED BIT USING FRESH WATES
NXB 3'	9'	8.5'	947		XER 7			55		RUN 02	49.2 TO 66.0 FT LIMESTONE, LIGHT GRAY (NG.5), SLIGHTLY WEATHERED, HARD, HIGH TO MODERATELY FRACTURED WITH HORIZONTAL FRACTURES. LIGHT GRAY(N7), HARD CHERT FILLED VOIDS, INTERBEDS, AND NODULES, FEW FOSSILS.  49.2 TO 50.7 HIGHLY FRACTURED WITH 80% CHERT.	1 0.15 0.55 25 2 0.25 0.55 52 3 0.25 0.5 52 3 0.25 0.5 52
NXB	8'	7.5	942				553.4	60 65 66		S MA	60.0 TO 61.8 FT VERTICAL FRACTURE.  65.6 FT FRACTURE FILLED WITH BLUE CLAY.	
								70			BOTTOM OF BORING AT 66.0 FT. BORING GROUTED TO SURFACE ON 6/24/86.  RED-ROCK QUALITY DESIGNATION FOR EACH RUN. AP-AVERAGE LENGTH OF CORE PIECES. LP=LONGEST PIECE OF CORE FROM EACH RUN.	ALL SOIL AND ROCCOLOR DESCRIP- TIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCI- ETY OF AMERICA 1948.



	C	FOL	OGIC	DRII	1 1	OC.	[*	POLECT			MET DON ;	CBO 1MC	CITC	14501		SHEET	#A.	HELE HE. G-20
TE		ROL R	DAD - N	IORTH C	ENTRA		COOPCOMITES							14301		FROM I	DE.	EVIDE
E GLIN			RTION (	F SITE		OTE CUM	DLOGY IN	r 10	N DRELL MAR		, 850 D MODEL	450	, 950 HOLE SHEE	OVERAL PROPERTY.	613	90  BOCK (		TOTAL BEPTY
/19.		6	/23/86		VL	KURT	JAEGER				E-45		6-1/4"/3"	32.5	<u>,                                     </u>		33.5	66.0
FE (		.9/92		COPE	90XES	SAPLE	3 0.10	- CAS			0.3 0.3	MET INC.	44.30*/5				32.5%	
PL	_		130 IN		CASS	C LEFT I	NONE	LDGTH			LOGGED F	Yı	LAWREN	E YOUNG /	/ AATI	KUKSON		
	<b>8</b> 5	E E			TAIR BUZZE						<del>, L </del>							R &
T.	N N	ECON	SAMPLE BLOWS  W PERSONER  RELOWDER		TESTS		<b>ELEVATION</b>	£ 6	397 January 106			BESCHPTI	DH #40 GLAS	SFICATION			_	IN LIVELS.
A10 ON	SAMPLES	300		8=3	33	TRE TRE	630.3	0	1	3							1	pacter of Leg. etc.
				B7 \$'	<b>20 S</b>		650.5		1			4), DR	Y, MEDIU	T, MODER			ALIA	5 FT DRILLE 6V4IN OD HO TEM AUGERS
								-	3	_							USING	CENTER PLI
Ş	18*	16"	10	3	4	6		5	4									
51	2'	1.9'	PUSHE	D <b>e</b> 90	0 PS]			6		2	ISH OR	NICE ( I C	YR 6/6),	CLAY, DAY MOIST, V	ÆRY S	STIFF,		
Ş	18"	15"	18	4	7	11	620.3	10	<b>3</b> //	3	(NT) SI STRING		ISES, PYR	OLUSITE 1	VE INS	MD		
S	18"	18*	20	6	9	11											BORE	
?*	10	10	20		,	,,		15 6.5	1//					LLY CLAY				TICAL PRATION.
	_					ļ			3/					6/5) TO				
۶ <u>۶</u> ۲'	5.5	3*	50+	50/2.5			610.3	20		35	WITH M	ED]UN ( HERT G	GRAY(N5) RAVEL ANG	TO VERY SEMI-CO	LIGHT MPETE	CRAY NT		
											CHERT	LAYERS.	, WITH DI	COMPOSED	LIFE	.51UPE	32.5	FT AUGER
\$\$ 2'	1.	1.	50+	50/1		-	-		**	6	-							SAL. TO 66.0 FT D WITH NOOB
								25									INPR	LINE DIAMON EGNATED BIT G WATER.
										1								ਦ ਜਾਵ <b>ਾਲ</b> ਾ19
<u>5,</u>	18.	10°	39	12	21	18		30		7								
				-			597.8	32.	.5		- 32.5 T	0 59.7	FT LINE	5104 , 14 , 50FT TO	N TO	BETGE Y HAR	, BLFL	INGTON/KED
	3.5	2.4	69				595.3	35	<u>.</u> <u>E</u>	I	SI CRYSTA	LLINE.	HIGH FE	RCENTAGE	OF W	<b>2</b> [T[H		,
			P00% \$1+5				<b>S</b> TE		PA	TRO		NORTH	CENTRAL				HOLE	G-20



PROJECT GEOLOGIC DRILL LOG H50-20 FLISRAP - WELDON SPRING SITE 2 - 2 G-20 SAMPLE RECOVERT
CORE RECOVERT
CORE RECOVERT
SAMPLE RECOVERT
W
PRENCENT CORE
RECOVERT
RECOVERT
RECOVERT MATER PRESLUCE TESTS BATER LEVELS. ELEVATION BESCRIPTION AND CLASSIFICATION MITTER METAL NEST IN MACTER OF A = 2 LIM, ETC. 595.3 OF CALCITE, OCCASIONAL STYLOLITES, SOME NO WATER RETURN VUGGY, OPEN ZONES. DURING CORING. 5.0 4.2 84 40 5.0 4.6 92 (FI) 13.5 10 5 45 BESSERE 11.2 20 5 4.0 10 5 5.0 5.0 100 8 50 ¥ 5.0 4.7 94 **5**5 59.7 TO 59.8 FT BANDS OF DARK GRAY CLAYEY MATERIAL - POSSIBLY PRESSURE 5.0 5.0 100 SOLUTION ACCUMULATE. 570.5 59.8 59.8 TO 66.0 FT LIMESTONE, LIGHT GRAY TO BLUE GRAY, HARD TO VERY HARD, SLIGHTLY WEATHERED CRYSTALLINE, FINE TO MEDIUM-GRAINED, LIGHT BLUE CHERT OCCURING IN IRREGULAR PATCHES, SLIGHTLY 5.0 5.0 100 FRACTURED WITH BROWN OR BLACK COATING OR STAINING ON FRACTURES, OCCASIONAL 564.3 EVIDENCE OF DISSOLUTION, FOSSILIFEROUS ALL SOIL AND ROCK BOTTOM OF BORING AT 66.0 FT. BORING COLOR DESCRIP-GROUTED TO SURFACE ON 6/23/86. TIONS FROM THE ROCK COLOR CHART ROD-ROCK QUALITY PRINTED BY THE **DESIGNATION** GEOLOGICAL SOCI-FOR EACH RUN. ETY OF MERICA, AP-AVERAGE LENGTH 1348. OF CORE PIECES. LP-LONGEST PIECE OF CORE FROM EACH RUN. HELL IN SS-SPLIT SPOOM ST-SIELBY TUBE, PATROL ROAD - NORTH CENTRAL PORTION OF SITE G-20 D-DEDMESON PARTORER DAOTHER



	G	EOL	OGIC.	DRIL	LL	.0G			ISRAP	WELDON	SPRING	SITE	JOB NO. 14501	-201	EET NO.	HOLE NO. G-21
ΠĒ	31	00 F1	N W OF	ASH F	POND		COORDINATES			1,336	<b>W</b> 52	,116			ON HORIZ. 90	•
7/9	/86		PLETED 8/1/86	DALLE	DR .		HNOLOGY	DRAL		IND NODEL		HOLE \$12E	OVERBURDEN 54.0		40.5	TOTAL DEPTH 74.5'
OFE I		<del>र्ल</del> ुडा . ब्रिट्ट		CORE	BOXES 3	SAMPL	EL 100	OF CASING	1	ND EL.	DEP TH/E	52.0'/5		a	₽ТΗ/EL TOP 54.0°	of Rock /584.7
MP L	HALE	IEN NE	19-17/FALL /30 IN				N HOLE DIA/	LENGTH	1	LOCCED	17:		A. ATKI	NSON		
DUMETER	SAMPLEN ADVANCE LENGTH CORE RUN	<b>1</b>	<u> </u>	P	WATER RESSURE TESTS	····	ELEVATION	H-100	PRAPHIC LOG		DESCRIPTI	ON AND CLAS	-		₩/	TES ON TER LEVELS, ITER RETURN,
AND DANE TE	SAMPLEY LENGTH	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOW "W" PERCENT COM RECOVERT	LOSS	PRESSURE P.S.I	240 e.	638.7		CRAM						, -	ARACTER OF BLUNG, ETC.
₹ 25				BT 6'	290 6	30 5	638.2	0.5				RAVEL, LI BLACK SI				2 FT DRILLE 61N 00 HOL-
• H										0.5 TO AND GR	7.0 FT ENISH	SILT, OF GRAY(5GY	RANGE (10Y 5/1), SO	R 4/5)	LOW S	STEM AUGERS CENTER PLU
\$\$ 2 <b>'</b>	16*	12"	<b>2</b> 5	6	12	13		5	1	BLACK	NOUULES	, VERY S	1111.			
HSA							631.7	7		7.0.70	12.0.5	T SILTY (	LAY MOT	TI ED		
ع								=			?(10YR	4/5) AND				
\$5 <b>2</b> *	18"	10.5	26	7	12	14		10		VEKT S	ilrr.				1	10.0 FT HOLE WAS
6. HSA							<b>6</b> 26.7	12		12.0 T	0 23.8	FT SILTY	CLAY. YE	LLOWIS	LOGG	DLOGICALLY ED BY LINE
SS 2"	18*	14"	30	6	11	19			-	ORANGE	(10YR ( /4 TO :	5/6 TO 10 10YR 4/6) 7 STIFF T	YR 5/4), , AND GRA	DRANGE AY(5Y-5)	ANAL CORP	YTICAL ORATION.
HSA								15 -				IDE STAIN				
ST 3"	24°	25°								10		•				
2 <b>.</b>	18*	18"	41	13	16	25		20 -		F 60						
e. HSA																
S2 <b>'</b>	ð,	3.5	50/3*	42	50/3		614.9	1 4				FT CLAYE				T0 74.5 FT
. HSA							6.4.7	25 -				10YR 6.5/ LACK STAI		, DRY,	WIRE IMPE	D WITH NXB LINE DIAMON EGNATED BIT
٠.							611.7	'		_ (N9) T	O OLIV	FT GRAVE	5/1) AN	GULAR		IG WATER.
2°	18*	10.	29	10	14	15	-	30		VERY		NGE (10YR	4/6) CLA	T MAIKL		PFT AUGER
6. HSA								1								
ص 52'	7*	5*	50/1	50	50/!	• -	604.5	34.2					7.00	51		LINGTON/KEO
			POON: ST=Si	T. BY 71			603.7	35		34.2	0 54.0	FT LIMES	TONE, DA	KK	FM.	10.



· pc	nd-	El.	OGIC یوا یو		WATER RESSURE						- WELDON SPRING SITE 14501-201 2	OF 2 G-21
AND DIAMETE	SAMPLER ADVANCE LENGTH CONE REA	SAMPLE NECOVERY	SAMPLE BLOWS  W PERCENT CONE RECOVERY	1055 N G.P.M.	PRESSURE P.S.	TME M MBAUTES	ELEVATION 603,7	<b>2</b> <b>2</b> 35	CRAMME LOG	SAMPLE	DESCRIPTION AND CLASSFICATION	WATER LEVELS, WATER RETURN, CHARACTER OF ORLLING, ETC.
	5.0	0.9	18				955,	1		RUN • 1	YELLOWISH ORANGE(10YR 6/6), EXTREMELY WEATHERED TO DECOMPOSED, CHERT AND LIMESTONE FRAGMENTS IN CLAY MATRIX. CHERT FRAGMENTS OCCASIONAL EXHIBIT DENDRITES AND ARE ANGULAR AND VUGGY.	
	5.0	0.4	8					49		RUN •2		AP LP ROC RUN (FT) (FT) (Z 1 C.1 0.2 0 2 0.0 0.0 0 3 0.15 0.45 38 4 0.0 0.15 0 5 0.0 0.1 0
I TO ONO	5.0	1.2	24					45 1 1 1 1 1 1		RUN •3		6 0.3 1.0 58 7 0.5 1.2 91 8 0.9 2.4 98 9 0.5 1.2 90 10 0.6 1.4 85
C. WILL VIAMON	3.0	1.1	37					50		PUN •4		7/31/86
יכ טאחאביר	2.0	0.6	30				584.7	54 -		RUN SS		ROD=ROCK OUALITY
NXBWINELINE CUME	3.0	2.4	80					55		AGN •6	54.0 TO 68.5 FT LIMESTONE, TAN TO BEIGE, MODERATELY WEATHERED, MODERATELY HARD, YELLOW-GRAY CHERT IN IRREGULAR BANDS AND PATCHES.	DESIGNATION FOR EACH RUN AP=AVERAGE LENGT OF CORE PIECE LP=LONGEST PIECE
XX	5.0	5.0	100					60 -		RUN •7		OF CORE FROM EACH RUN. ALL SOIL AND ROCK COLOR DESCRIP-
	4.0	4.0	100	0.3	20	6		65 -			63.7 TO 65.2 FT DUARTZ FILLED VUGGY ZONE.	TIONS FROM THE ROCK COLOR CHART PRINTED BY THE GEOLOGICAL SOCI- ETY OF AMERICA, 194
	4.5	4.5	100	0.1	30	5	570.2	58.5 70 -			68.5 TO 74.5 FT LIMESTONE, WHITE TO LIGHT GRAY, FRESH, HARD, CRYSTALLINE,	
	4.0	3.9	98				564.2	74.5			STYLOLITES.  BOTTOM OF BORING AT 74.5 FT. BORING	
	22:2		POON: ST=S	PHELBY TO Rio-Othe			डा <u>६</u>	1	1		GROUTED TO SURFACE ON 8/1/86,  300 FT N W OF ASH POND	HOLE NO.



PROJECT **#** BARET MA MOLE NO. GEOLOGIC DRILL LOG GW-1 FUSRAP - WELDON SPRING SITE 14501-201 1 0 2 MELE FROM MORE. COOPCOUNTES 90 **W**52,554 500 FT. WEST OF ASH POND N100,858 TOTAL DEPTH DALT MAKE WED HODE! er re DATE THE ELD DEPLETED. ME CLIN DOLLER GEOTECHNOLOGY 60.0 6'/3 26.5 335 CME-55 7/10/86 7/H/86 INC. DING. THE OF SEPTIMEL STOLES SATER MOUND EL. COME BOXES CHECK COME DECOMEDITE JO 26.51/585.6 23.3/588.8 30.95/92 LOSCED BY. LIMPLE MANDER MEDINT/FALL CASHE LETT IN HOLE DIA ALDIETH ALATKINSON / ELBERGLUND 2/61 MO LBS/30 IN BATER MESSURE STEE DO BAR INT TESTS SAMPLEN CORE BATER SETUDIA D. FVATION MELCAPTON AND CLASSFICATION WITTE AN 32 BLANC. ETC. 612.1 0-14.7 FT DRILLED 611.6 0.5 0.0 TO 0.5 FT DRGANIC DEBRIS - LEAVES WITH 6-INCH DO HOL-ROOTS, ETC. LOW STEM AUGER 0.5 TO 6.0 FT SILT (ML): BROWN TO LIGHT USING CENTER PLUG. BROWN CLAYEY SILT WITH BLACK AND RUST STAINED MODULES. 28 18" 13" 19 33 61 5 6.0 TO 14.7 FT GRAVELLY CLAY (GC): WHITEISH TO YELLOW - GRAY (10YR 8/2) CHERT IN DRANGE (10YR 4/4 TO 10YR 6/6) 0 TO 10.0 FT BORE CLAY MATRIX. 20 25 HOLE WAS RADIO-18" 15" 45 11 LOGICALLY LOGGED BY ENERLINE ANALYTICAL CORP-ORATION. 24" 17" 14.5 FT AUGER REF SS 50/2 14" 13' 63+ 11 13 597.4 USAL. 14.5 TO 26.5 14.7 TO 26.5 FT GRAVELLY CLAY, ORANGE FT DRILLED THRU CLAY (10YR 4/4 TO 10YR 6/6) CLAY WITH CHERT AND FRACTURED CHERT WITH TRICONE BIT GRAVEL AND SENICOMPETENT CHERT LAYERS. TO TOP OF SOUND BEDROCK. TRICONE RESIDUUM 2-7/8 7/14/86 BLE INCTON/KECKLIK FM. 26.5 TO 60.0 FT CORED USING 585.6 NXB VIRELINE 1002 NOCB 0.5 0.5 DIAMOND INPREG-26.5 TO 40.5 FT LINESTONE, YELLOWISH NATED CORE BIT AND BROWN (10YR 5/4), MODERATELY WEATHERED FRESH WATER. TO DECOMPOSED, MODERATELY TO SLIGHTLY NXB 5' 4.65 93x FRACTURED, MODERATELY HARD, WITH MEDIUM 30 100 - 0 X GRAY (N6), HARD CHERT FILLED VOIDS. ₩ - 40.1 FT 5 0 10 LP = 0.1 FT 34.5 TO 39.5 FT CLAY SEARS. RLN +2 20 5 RCC - 11X # - 0.3 FT 5' 4.3 86% LP = 0.5 FT 577.1 AL III 911 SS-SPLIT SPOON ST-SHELBY TUBE ON-1 500 FT WEST OF ASH POND BEDEDORSON PEPTICHEN DECTHER



	G	EOL	.OGIC	DR	LL I	.0G	M	<b>DLECT</b>	FUSF	eap P	- WELDON SPRING SITE MS		T MC. 2 or 2	MOLE NA.
LE TYPE BERTON	SON MAN	R CONFRT	THE BLOWS		BATER PRESSURE TESTS		BLEVATION	NL AGE	MC 106	AMPLE	BERGIPTION AND CLASSPICATION		1071 1047 1047	ES ON BR LEVELS, BR RETURN,
3 8		3	3 2	S = 2	35.5	1 = 5	577.2	35	STANK				-	LBC, ETC.
JOGB	5'	4.8'	<b>9</b> 62				571.6	40 - 40. 5		RUN 04	39.5 TO 40.5 FT DECOMPOSED.  40.5 TO 53.5 FT LINESTONE, L (N7), SLIGHTLY WEATHERED, NO		AP LP RR	UN +3 D - 35X - 0.25 FT - 0.45 FT UN +4 D - 46X = 0.3 FT - 0.7 FT
NXB 3	5'	4.0'	BOX					45 -		FRUM +5	MARD, SLIGHTLY MORIZONTALLY WITH MARD, WERY LIGHT GRAY ( FILLED VOIDS.	FRACTURED,	AP LP	NN +5 20 = 41X + 0.25 FT + 0.8 FT
3'		2.0'						50 -		7 FR. O.			AP LP	20 = 20X = 0.1 FT = 0.9 FT
NXB 3'		2.9' 4.8'					558.6	53. <del>5</del>		RUN +6 RUN +	53.0 TO 53.5 FT YELLOWISH BR (10YR 5/4)DECOMPOSED ZONE. 53.5 TO 60.0 FT <u>LIMESTONE</u> , N (N6), FRESH, SLIGHTLY HORIZO CTURED, MODERATELY HARD, WIT	MEDIUM GRAY ONTALLY FRA- TH LIGHT BLI	AP LP	NUM •7 20 • 47X • 0.2 FT • 0.55 F' NUM •8 20 • 73X • 0.3 FT
NCB 3'	3'	3.0	100x				552.1	60 -		RUN *9	GRAY (58 5/1), HARD CHERT FI OCCASIONAL STYLOLITES. BOTTOM OF BORING AT 60.0 FT. HOLE TO 8-1/2 INCH AND INSTA	. REANED	R	* 0.9 FT  RUN *9  OD = 82%  * 0.3 FT  * 0.7 FT
											SIGL STAINLESS STEEL MONITOF SCREENED FROM 48.0 TO 58.0 F AP-AVERAGE LENGTH OF CORE PI EACH RUN. LP-LONGEST PIECE OF CORE FRO ROD-ROCK QUALITY DESIGNATION RUN.	FT. PIECES FROM NON EACH RUN	COLOR FROM 1 CHART THE G SOCIE	OIL AND ROCK DESCRIPTION THE ROCK COLOR PRINTED BY EOLOGICAL TY OF CA, 1948.
			P00m 574			<u> </u>	<b>S</b> ALC		<u> </u>	1_	500 FT WEST OF ASH POND		ADLE US	



	GE	OL	OGIC	DRIL	LL	.0G	COGREGATES			- WELDON			1450	-201	SHEET (	<b>~</b> 2	HOLE HO.  GHY-2/2A  MEANING
ITE	WE.	ST S	IDE OF	ASH PO	MD		COUNTRATES	-	W-2 N10 1-24 N10		<b>152</b>	, 250 , 253			90		•
7/1/	784S.		127ED 22/86	DONLLE	<b>JR</b> (		HNOLOGY NC.	0	MOB	NO MOCL LE B-57		8'/3"	24.1		MCC.	7.) <b>5.</b> 5	FOLO
	ECD 10	m /		CAPE CAPE	2 (2)	SMOLE		a casi	HE   1990	MD D.	SO INC	3L0/59			150°TE/	D. 10 0	7 NACK 7595.0
MPL		4/14	DIT/FALL	13.0			H HOLE DA.A	<b>Д</b> СТН		524.0 LOGGED (	7,	30/33.			1	23,0 /	1330
	140	LBS/	30 N				2/610	т —	1				AATIO	SON	1		
AND DRAWETER	THE MODELLE STATES	COR RECOVER	PERCENT CONT.	Ħ	ESSURE TESTS	TAK N N DUTES	ELEVATION .	E	Service 106		BESCHP TI	OM AMD CLAS	SFICATION			2	TES CON TER LEVELS. TER RETURN. TOUR RETURN. TOUR TET CO.
	~	-	<del> </del>	157 6"	7.	30.5	624.0	0		0 TO 3	5 FT S	ILTY CLA	L TAN-B	ROMN,	AITH		5 FT DRILLE
HSA							•		1//	LINEST	DNE GRA	VEL.			İ		SIN OD HOL- TEM AUGER
و					• • •					1						USING	CENTER PLU
\$5 2*	18"	11.	25	4	15	10	<b>620.</b> 5	3.5	<del>-</del>			CLAY, O					
								5 -	1//			PS AND B Fragmen		TH 6/4	4)		10.0 FT
6 HSA							617.0	,		<del> </del>		_			·		IOLE GNV-2 IADIOLOGICAL
								'	֓֞֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֓֡֡֡֡֓֓֡֡֡֡֡֓֓֡֡֡֡		12.5 F	T CLAYEY	SILT, D	ARK DI	IVE T	LOGGE	D BY
SS	18*	14"	7	3	3	4			<u>-</u>     [	GRAY (	31 <b>4/2</b>	10th 4/	27, 301	,	<b>.</b>		RATION.
S. S.	i							10	3    [		,						MY-2 WAS AB
इ	12*	13°					611.5	12.5	4111							1	ED WHEN A DND DRILL BI
S 2	18"	i3°	26	15	9	17	6,,,,	1,2.3				FT <u>GRAVE</u>				1	EAMING SHELL BROKEN OFF
								15	3/1	MATRIX						IN T	E HOLE AT A
HSA										CLAY V	TH CH	FT BROWN ERT GRAVE	L.			HOLE	H OF 45.5 FT CMV-2A WAS
.9									35			FT MOTTL 6) CLAY 1					LED <b>70 REPLA</b> 2.
<u>د</u> ک	9,	9.5	50/3*	10	50/3					10YR 1	/4) CH	ERT GRAVE	Ί.				
								20	39			ITH WHITE					FT AUGER- RE
HSA																USAL	. BURLINGTO
ع.							ļ		1/2			FT DRAW					UK FM. TD 60.0 FT
SS 2'	4"	6"	50/4	50/4	-	-	<b></b>		. 122	5						1	D WITH NOB LINE DIAMON
HSA L				1			599.5	25		24.5	0 29.0	FT LINE	STONE E	CTREME	LY	INPR	EGNATED CORE
	4.0	0.2	5							ATELY		DECOMPO	scu, <b>sur</b>	101	wer"	641	MIND BAILK
DIAMOND									扭	<b>E</b>							
0 /	1.2	1.0	83				595.0	29	出	2 2	PA 8: :	ET 1 14F	CTOME T	AN TO		-	
E.			71					30	押	YELLO	¥ (5Y 1	FT <u>LINE</u> //3 TO 5Y	8 8/2), 1	HODER	ATELY	V	7/12/86
BARREL		2.0	L -'-	GUT						FRACT	URED, C	ITELY WEA OCCASIONA	L HIGHLY	WEAT	HERED	•	_
COME	1.0	0.8	80	2A					扫	ZONES	WITH C	LAY SEAM WRD, CHE	S, WHITE	(N9)	TO		GW-2, N GW-2A
<b>E</b>	5.0	4.3	86				589.0	35		PATCH	ES, OCC	ASTONAL	CRYSTAL	FILLE	O VUGS		
	86-5	PLIT S	POON STE				BITE			₩ C7 €	ine ne	ASH POND				HOLE	CM-2/2A



	G	EOL	OGIC	DRI		.0G	-	OECI	FUSI	WP	- WELDON SPRING SITE JOB NO. SAMET M50H-201 2	er 2 Carr-2/2A
SAMPLE TIPE BO GAMETER	DR ADVANCE	RECOVERY RECOVERY	SAUTIC BLOWS  W FRICENT CONE RECOVERY	•	MATER TESTS		ELEVATION	# <b>2</b>	PRAME LOG	SAMPLE	BESCRIPTEDN AND CLASSIFICATED	MATES ON BATES LEVELS, BATES RETURN COMMITTER OF
3 8	DIAME OF THE PERSON OF THE PER	3 2	MERCEN ME	2 = 3	MESSUR D.S.	¥ = 5	589.0	35				MILLIMS, ETC.
				0.9	15	5						ROD = 0 X AP = 0.1 FT
	_			3.2	30	6			出	-		ILP = 0.1 F7
	5.0	4.6	92	1.9	15	5		40	臣	RGN 65	41.2 FT HORIZONTAL FRACTURE FILLED WITH	AP - 0.2 FT
D 811										_	GRAYISH GREEN (10G 4/2) CLAY.	RCD = 35X AP = 0.2 FT
A/ DIAMOND	5.0	2.8	56					45 -		9		LP = 0.4 F7
BARREL W										<b>M</b>		AP = 0.2 FT LP = 0.4 FT
COPPE BA								50 -		-	50.7 FT HORIZONTAL FRACTURE FILLED WITH	ROD = 35X AP = 0.2 FT
ĐX	5.0	4.8	96				572.9	51.1	其	2	GRAYISH GREEN (10G 4/2) CLAY.  51.1 TO 60.0 FT LINESTONE, NEDIUM LIGHT	LP = 0.5 F7
		-		0	15	5					GRAY (NG), SLIGHTLY WEATHERED TO FRESH, HARD, WITH OCCASIONAL VERY HARD CHERT NODULES AND BANDS, OCCASIONAL WEATHERED	AP = 0.2 FT
	5.0	5.0	100	0	30	5		55 ·	這		ZONES (52.0 FT,53.7 TO 54.1 FT,56.6 TO 57.1 FT), STYLOLITES, OCCASIONAL FOSSILS SLIGHTLY FRACTURED WITH OCCASIONAL	PLN +7
	-					_		.		160	ZONES OF HIGH NECHANICAL FRACTURING.	LP = 0.8 FT RLN +8
	2.0	0.9	45	-			564.0	60			BOTTOM OF BORING AT 60.0 FT REAMED HOLE	MCD = 43X AP = 0.2 F7 LP = 0.5 F7
									1		TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 48.0 TO 58.0 FT.	SOIL AND ROCK CO
									<u> </u>		BORING GHW-2 WAS GROUTED TO SURFACE ON	OR DESCRIPTIONS FROM THE ROCK
									1		7/8/86.  AP- AVERAGE LENGTH OF CORE PIECES	COLOR CHART, PRIN' ED BY THE GEOLOGIC SOCIETY OF
									1		FROM EACH RUN.	AMERICA, 1948.  REN *9
									1		RUN.	ROD = 0 X AP = 0.1 FT LP = 0.3 FT
									1		ROD- ROCK QUALITY DESIGNATION FOR EACH PLIN.	Sr - 9.5 T1
ļ <u>.</u>				Dec. 20 -			SITE		]_			MOLE NO.
			SPOON STA				<b>W</b> 16				WEST SIDE OF ASH POND	GNV-2/2



	G	EOL	OGIC	DRIL	LL	OG		PROJECT		P -	WELDON	SPRING	SITE	14501	-201	1	<b>#</b> 2	HOLE NO.
TE	S	DUTHN	EST OF	ASH PO	OND		COORDONTE	3	N	100	,347	<b>V</b> 52	2 <b>, 29</b> 9		AMELE	FROM H		BEARDG .
(1)	/86	1	PLETED /21/86	DRELLI	D) (		HNOL DGY		DRLL MA		0 M000. -57/CME	75.0	6'/3'	28.0		MCX (	TJ.	TOTAL BEPTH
		RIFIJ		COME	DOMES.	SAPU		of Cu			D EL.		- Gone M			1	EL TEP O	
		LB/67			3	6		-		63	ILOGOD I	<u> </u>	30.1/59	8.7			30.81/	<b>598.</b> 0
			BOT FALL			E LL	# HOLE DA. 2º/61				LOUIS I	171	AAT	KINSON/ELB	ERGLU	ND		
	<b>1</b> 5		<b>.</b>		BATER ESSURE					П								
E		ALCONO.	E 50 F		TESTS		ELEVATION	F	PAPPE LOG	7		MESCROT	OH AND CLAS	SETCATION				EN LEVELS,
9	LENETH CONE	100	PENCENT PECON	8-4	P.5.1	A = 2		8		2							CDA Diffe	MACTER OF LINE, ETC.
	313	310	<u>ب</u> او	121 6.	<b>30</b> ('	30.5	636.8	0	1.	Ц								
							635. B	١,		4			<u>ravel</u> , l Black (n					D FT DRILLE -INCH 00 HCL
ž									<u> </u>				CLAYEY					TEM AUGER Center Plui
0			-					-	41111				IDE STAIN	-	~			DENTER TES
								5	<u> </u>									
٠	105	17"	12	4	5	7			4	11-								UNISUCCE SSF
•	10	11	12	-	2				<u> </u>	SS							1	pt to take 1 tube sampl
SA							628.8	8	1//	<u></u>	• 0 70	12.0	FT CLAY,	MOTTLED (	TO A N C		1	
• C	18"	181	12	3	5	7			1//	725	-BROWN	-GRAY	(10YR 5/4	), STIFF,				
•								10	3//	7	HANGAN	ESE OX	IDE STAIN	IING.				10.0 FT B0
SA ST	041	261							1//	1							LOGIC	ALLY LOGGE
3°	24	26					623.8	13	*//	4							-	ERLINE TICAL CORP
S.	18"	13°	19	4	В	11			<b>Y</b> //	15			FT SILTY OWISH BRO			D	ORATI	ON.
								15	1//	<del>\\ \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\</del>	LIOYR	5/6 TD	10YR 5/5	o, with (	FINE-			
HSH									¥//				MANGANES					
9				,					1//	1	AND FI	LLINGS	COMMON.					
<u>ss</u> 2'	18"	15'	14	5	6	8			<b>Y</b> //	15								
<u>-</u>		<del> </del>				<del>                                     </del>	1	20	1//	75	1							
¥S.							614.8	22	1//									
6							017.0	"	-37		22.0 T	0 28.0	FT GRAVE	LLY CLAY	, DRA	NGE		
\$S	18.	13°	55	43	26	29	1		137	35	AND CR	AY (10	YR5/5),H/ R8/2) AND	URD, WITH			1	
	-	<del>                                     </del>	<del>                                     </del>				1	25	32	عر			T GRAVEL		.4100	· 71		
¥			1						37									
<u>.</u>		ļ					608.1	28	12	1								T AUGER REFL
							500.	"		1			FT GRAVI					10 59.0 FT CO NXB WIRE (
				<u> </u>		-	4	30		4=	AND G	TAY (10	MR 5/5)	SILTY CLA	Y, WI	TH	DIAM	OND IMPREG
NXB	61	1.4	231						3/				ERT LAYE				USIN	G WATER.
_				3.1	10	5			1/2	4							RES1	
									3/	1	_							
	<u></u>	1		<u></u>		]	601.	8 3	5 1	1							HELL I	,
			POON STASI			ľ	MTE				SOLITIME	ST OF	ASH POND					<b>CM</b> -2



	G	EOL	OGIC	DRI	LLL	.0G	P	O.ECT	FUSF	WP	- WELDON SPRING SITE M501-201 2	er 2 GAW-5
SAMPLE TYPE DO GAMETER	ENCTH COTE NUM	LE RECONDIN	SAUTE ROPS W PREDIT CORE	2 4	BATER TESTS	E (5	ELEVATION	Ē	Partic 166	27.0875	BESCRIPTION AND CLASSIFICATION	MOTES ON BATER LEVELS, BATER RETURN DWALTER OF
2 2	<b>₹</b>	38	3 12	3=3	27	- 5	EQL8	35	<b>6</b>		·	METHE ELC
3, KXB	5'	0.7'	14X				598.0	58.8		FUN 62		<b>▽</b> 7/10/86 <b>8.5</b> 6.1NST001/850KUK FN.
NXB 3'	5'	4.8	<b>9</b> 62					40		RUN +3	38.8 TO 48.5 FT LIMESTONE, YELLOWISH BROWN (10YR 5/4) TO LIGHT YELLOWISH GRAY (5Y 7/1), MODERATELY WEATHERED, MODERATELY HARD, MODERATELY FRACTURED, FRACTURES ARE HORIZONTAL WITH SOME FILLED WITH CLAY, VERY HARD, GRAY (NG) CHERT FILLED	RUN 41 ROD = 0 X AP = 0.1 FT LP = 0.2 FT RUN 42 ROD = 0 X
NOŒ 3°	5'	4.6'	922	0	10 20	5	588.3	45		FUN 04	45.6 TO 48.5 FT EXTREMELY WEATHERED AND FRACTURED ZONE WITH CLAY SEAMS.	AP = <0.1 FT LP = 0.1 FT RUN +3 ROD = 692 AP = 0.35 FT LP = 0.8 FT
NXB 3'	5'	4.6'	92%				300.3	50 -		RIN 65	48.5 TO 59.0 FT LIMESTONE, YELLOWISH BROWN (10YR 5/4), SLIGHTLY WEATHERED, MODERATELY HARD, SLIGHTLY FRACTURED, WITH LIGHT GRAY (N7), HARD, CHERT FILLED YOLDS, 20-30% OF CORE IS CHERT.	RUN #4  ROD = 33X  AP = 0.25 FT  LP = 1.1 FT  RUN #5  ROD = 72X
NXB 3'	5'	4.7	94%				577.8	55		20 M 85		AP = 0.3 FT LP = 0.8 FT BUN +6 ROD = 60X AP = 0.3 FT LP = 0.8 FT
											BOTTOM OF BORING AT 59.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 48.0 TO 58.0 FT.	
											AP= AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.  LP= LONGEST PIECE OF CORE FROM EACH RUN.	SOIL AND ROCK COLOR DESCRIPTIONS FROM THE ROCK COLOR CHART,
											ROD - ROCK QUALITY DESIGNATION FOR EACH RUN.	PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.
			PODE STAS				im.		1_		SOUTHWEST OF ASH POND.	MOT NO



HOLE HO. 4 -GEOLOGIC DRILL LOG 14501-201 **CHY-4** FUSRAP - WELDON SPRING SITE 1 # 2 COORDONTES MILLE FROM HORG. MI S) W51,750 SODET MORTH OF ASH POND N101,450 TOTAL DEPTH DAST MYE WE REDE! HOLE SEE DECEMBER FTJ CONFLITED ... DALLER **GEOTECHNOL** DGY 72.0 MOBILE B-57/CHE 55 6.12 910 6/28/86 7/24/86 INC. CONE RECOMPTIVE 1./D COPE BOXES SWATS EL TOP OF CASES CROLED D. SEPTIMEL STOLING BATER SEPTIMEL TOP OF MICK 5L0'/59L8 514/5914 \_22.7/58 642.8 MAPLE MARER WEIGHT/FALL CASHE LEFT IN MOLE DALALDIETH LOSSED BY MO LBS/30 N 2/165 **ALATKINSON/JKAISER/EJBERGLUND** MATER PRESSURE OTES DA MATER LEVELS TESTS SAPPLE IN O MESCROTTON AND DIASSEATION MITTER RETURN ELEVATION PACTED OF 12.5 642.8 0 157 6° 20 5 0-33.0 FT DRILLED D TO 0.5 FT SILTY CLAY, BLACK (NI), DRY 642.3 0.5 TO MOIST, LOW PLASTICITY, SOME ORGANICS, WITH 6-INCH OD 돐 HOLLOW STEM AUGERS SOME FLYASH. ۍ 0.5 TO 7.0 FT CLAYEY SILT, MOTTLED LISING CENTER PLUG. YELLOW-DRANGE (10YR 6/6) AND PALE DLIVE 18" 14" (10Y 6/2), VERY STIFF, LOW PLASTICITY, 25 6 14 11 5 MOIST. 635.8 7 7.0 TO 12.0 FT SILTY CLAY, MOTTLED YELLOWISH-BROWN, STIFF, HIGHLY PLASTIC, 0 TO 10.0 FT BORE SAND-SIZE LIMESTONE FRACMENTS, BLACK 18" 16" 5 9 13 HOLE WAS RADIO-MANGANESE DXIDE STAINING. 10 LOGICALLY LOGGED BY EBERLINE ANALYTICAL 12 630.8 S1 3° CORPORATION. 12.0 TO 27.0 FT SILTY CLAY, YELLOWISH BROWN (10YR 5.5/6), VERY STIFF, FEW ROUNDED PEBBLES AND SOME ANGULAR WEATH-15 9 18" 16 29 14 ERED CHERT GRAVEL, BLACK MANGANESE OXIDE STAINING COMMON. HS. ٠, 18" 19 14 20 ء: 18" 20.5 31 10 13 18 25 #S# 615.8 27 27.0 TO 33.0 FT GRAVELLY CLAY, YELLOW-• DRANCE-BROWN (1DYR 4/5) CLAY WITH 7. 6" 50/3" |50/3" ANGLEAR WEATHERED CHERT GRAVEL. S2° 33.0 FT AUGER 30 REFUSAL. INTERFACE 조 PERMEABILITY TEST PERFORMED AT 33.0 ء: FT. 33 609.8 33.0 TO 51.0 FT GRAVELLY CLAY REDOISH **RESIDUUM** BROWN, WITH WEATHERED CHERT GRAVEL AND 607.8 LAYERS OR LENSES OF CHERT. 211 SS-SPLIT SPOOM STASHELBY TUBLE DW-4 500 FT WORTH OF ASH POND S-DEDOCTOR PHATCHER O-DIVER



	G	EOL	OGIC	DRII	L l	OG	P	D.ECT	FUSA	WP	- WELDON SPRING SITE JOB III. SMET 2	or 2 GMF-4
DO DAMETER	LENGTH ONE PUN	RECOVERY	THE BLOWS WEEKEN CONE	•	BATER TESTS		ELEVATION	H-CM	PRAMIC LOG	MATE	RESORPTION AND CLASSFICATION	ESTER DIO BATER LEVELS, BATER ETRIBAL
3 8		38	MACOUNTY AND A PARTY OF THE PAR	2 = 3	TS'd		607.8	35	3		·	BREALDS, ETC.
FR10	ONE d.	33,	-37'									33.0 TO 37.0 FT WITH 6-INCH TRICONE ROLLER BIT USING WATER.
3°	5'	1.6'	32x					40		RUN •1	40.5 TO 41.5 FT DECOMPOSED LINESTONE	37.0 TO 72.0 FT COMED WITH LINE DIAMOND INPREGNATED CORE BIT LISING WATER. 41.0 FT WATER LOSS.
3°	5'	0.7'	14%					45		RUN +2		
3°	5'	1.0'	20x				591.8	50 51		RCN •3		BURL INGTON/KEOKUK FN. 27/24/86
мХВ 3'	3'	2.7	<b>9</b> 0x	0	10	5		55		RUN 64	51.0 TO 70.0 FT LIMESTONE, YELLOWISH BROWN (10YR 5/4), MODERATELY WEATHERED, MODERATELY HARD, FEW HORIZONTAL FRACTURES (CLAY FILLED), WITH HARD, NEDIUM GRAY (N7) CHERT FILLED VOIDS, CORE IS 20X	AP LP Bun (FT) (FT) BED 1 0.15 0.3 Re
KXB 3'	2'	2.0	1002		20	5					CHERT, 55.0 TO 57.0 FT DECOMPOSED LINESTONE WITH CLAY SEAMS, CORE IS 40 TO 50% CHERT.	2 0.1 0.2 02 3 0.1 0.3 02 4 0.2 0.35 262 5 0.2 0.6 502 6 0.35 0.05 632 7 0.3 0.9 482
3°	5'	5.0	100%					50		RIN %	59.0 TO TO.0 FT LINESTONE BECOMES CLAYEY, IN SOME CASES FRIABLE. 61.0 TO 62.0 FT VERTICAL FRACTURE.	8 0.35 0.85 663
NXB 3'	5'	5. 0	' 100z	0	10	5		65		PIN 67	65.0 TO 69.0 FT IRREGULAR CHERT FILLED VOIDS IN DECOMPOSED LINESTONE, CHERT IS WHITE (N9) TO GRAY (N6).	AP-AMERIAGE LEIGTH OF COM- PIECES FROM EACH RUM. LP-LINECEST COME PIECE FR CACH RUM. MIN-BOCK CLAM. 27Y DESIGN- ATION FOR EACH RUM.
2, 1008	5'	4.1	94%				572.8 570.8	70 72			69.0 TO 70.0 FT SWIRLED PATTERN OF CLAYEY LIMESTONE AND CHERT. 70.0 TO 72.0 FT LIMESTONE, GRAY(NB), HARD SLIGHTLY WEATHERED, STYLOLITIC, CHERT, TO. 7 TO 70.1 VERTICALLY FRACTURED CHERT INTERBED, IRON STAINED.  BOTTOM OF BORING AT 72.0 FT. NEARED	
									1		HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 65.5 TO 75.5 FT.	MALER PANET, PRINTE THE MERICAL SECTE MERICAL 1948.
			POON STA IN PARTICLE				<b>SETTE</b>				500 FT MORTH OF ASH POND	IBLE ID.



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SITE	G	EOL	.OGIC	DRI	LLL	.0G	COORDONTES		USRAP	- 1	MELDON	SPRING	SITE	14501	-201	<u> </u>	<b>a</b> 3	GMY-5
	NOR	TH EI	OF AS	H PON	D DAM		COURTONIES		NI	01,	131	<b>W</b> 51	<b>, 9</b> 50		AMELL .	FROM H		EARC -
7/	/86		/22/86	DPLL	ER GE		OLOGY INC	) DA	KLI MAKE		1000. E-45		HBLE \$42E	OVERLAND:		MC (	71.2 31.2	TOTAL BOPTH 76.0 FT
COPE		DITO 1.	<b>/2</b> 0	COPE	BOXES	SAMPL		er case		100	EL.	BEPINE	- GLOTHE AV	TER		<u> </u>	D. THE O	NOCK
SME	• • • •	5/70.	S SENT/FALL		4	<u>ک</u> ا	BI NOLE DA.A	.DETH		63!	5.7	171	NOT DET	ECTED	•		4LEFT/	590.9
<u> </u>	140	LBS	/30 N				2"/78.5"	<del>, ,</del>					·	TETAR	ER			
LE TYPE MAETER	Deve so Had	COM MICONIAN	SAMPLE BLOWS TO THE PROPERTY COME RECOVERY	P	BATER RESSURE TESTS		ELEVATION	MEPTH	DELPHE 106	SMETE		<b>BESON</b> TO	OH AND GLAS	SFICATION	,		GET GAT	ES DIN ES CETURAL ES PETURAL
Tage of	35	18		12 c.	nes ac	1 2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	635.7	0									3	MACTER OF LING, ETC.
6"8 HSA							635.2	0.5			CRAVELS	STICIT LOCAL FT SI	Y. MOIST LY. LI (ML-M	(CL): BL. . ORGANIC H): GRAYI	S. Sh	1)	WITH E	FT DRILLED IN OD HOL- EM AUGER CENTER PLUG.
\$\$ 2 <b>*</b>	18"	12"	24	6	12	12	:	5 -		1	MOIST.	MOTTLE		PLASTICI IGHT BLUI		AY		·
6.8 HSA							629.7	6			YELLOW (10YR (	BROWN( 5/6). M	10YR 5/4 ED. TO H	Y (CL): M ) TO YELL IGH PLAST	OW DR ICITY			
\$\$ 2"	18*	16"	12	3	4	8		10		2	GRAVEL	TO SAN		. TRACE F ARTICLES	_			IO.DET BORE- VAS LOGGED TRI INF
6°B HSA ST								111					<b>G</b> ILITI				ANAL Y	TICAL
\$T 3' \$\$ 2'	24"	24°	100%	4	6	8				3	13.5 F	BLACK	OXIDE S	TAINING N	OTED.		11.561	T SHELBY TUBE
6.8 HSA								15										
\$\$ 2*	18"	18*	16	5	6	10	616.2	19.5		4	19.5 F			L AND CLA	v 166	1,		
6"8 HSA								20		-	YELLOW BROWN! PLASTII ING. GI	ORANGE IOR 4/6 CITY. M RAVELS	(10YR 6/ 5). STIFF DTTLED. OF LIGHT	6) TO MOD . MEDIUM BLACK DXI GRAY(NB)	. RED TO HI DE ST TO	DISH GH AIN-		
\$5 2'	18"	18*	15	4	7	8		25 -		5		LOCALL		LIMESTON EDS OF \$1				
6°Ø HSA												v [ [ .		•	,			
<b>5.</b> 22	18"	18.	14	5	6	8		30		6				•			REFLS	_
6.0 HSA												AND CHE		S OF VUGO WITH RED		€-	LINE	O 76. OFT COME NXB WIRE DIAMOND
80X		. 85'					600.7	35		3							BIT U	SING WATER.
	>00	<b>1</b> 50%	COM STAGE PAPTOLERS STEM AUG	0-OTHER		]*	TT.			NOR	RTH END	OF ASH	POND DA	N			NOTE NO	<b>GNV</b> -5
										_								



	G	EOL	.OGIC	DRII		.0G	P	NO.ECT	FUSRAP	- WELDON SPRING SITE M501-201 2	er 3 CMA-2
LE TYPE MARTER	MANAGE CORE NUM	RECOVERY	TO TO TO TO TO TO TO TO TO TO TO TO TO T	•	BATER TESTS	:	ELEVATION	At 438	PAPPE LOS	BESCRIPTION AND CLASSIFICATION	METER ON BATEN LEVELS, BATEN METARIN
3 2		100	1302de 1307S	# <b>7</b> 1082	DES PLE	786 2 2 2 2 2 2 3 3 4 3 4 4 3 4 3 4 3 4 3 4	600.7	35		·	SHALMS ETC.
	5. 0'	0,	0x	13.8	10	10			KLIM *2		32.7 TO 41 FT: DRILLING FAST AND SLOW. CIRC. LOSS B 42 FT PERFORMED PACKER TEST 30.8-44.7 FT
				15.5		5		40 -		41 FT FRACHENTS OF BROWN GRAY(5YR 4/1) LINESTONE AND CHERT. VUGGY.	UNABLE TO TAKE TESTS LOWER IN
- 1	5. 0'	1.6'	32%	13.1		5	590.9	44.8			HOLE EVEN AFTER REAMING. BLOCKAGE AT ~45FT BURLINGTON/KEOKUK FM.
	1.7'	1.2	712					45		44.8 TO 66.9 FT LIMESTONE, LIGHT BROWNISH GRAY(5YR 4/1). MODERATELY TO SEVERELY WEATHERED. CLOSELY TO MODER- ATELY FRACTURED. FRACTURES GENERALLY	<b>***</b>
B CORE	3.3'	2.65	BOX					50 -	•	10° TO 30°, IRON STAIN ON FRACTURE SURFACES. CHERT LAYERS AND LENSES PRESENT. SLIGHTLY WEATHERED AND VERY HARD. VUGS, LOCALLY.	AP LP RED BLM (F1) (F1) (X) 1 <0.1 .2 0 2 0 0 3 <1 .2 0
<b>BXN</b>	5.0	4.85	97%					55		47.7 - 48.2 FT YUGS 61.0 - 62.0 FT YUGS	3 4 .2 .6 40 4 6.2 .6 40 5 0.1 .5 6 0.4 1.1 7 0.3 .6 8 0.3 .8 66 9 0.3 .7 71 10 0.2 .8 53
	5.0	4.9	98%					60		63.6 FT A 1/8° THICK GREEN (5GY 3/2) SILTY CLAY SEAN (8 ~ 5° )	
	5.0	4.1	<b>9</b> 6%					65		63.6 - 64.6 FT LINESTONE, WHITISH GRAY (N7), SLIGHTLY WEATHERED.	
	5. (	4.	7 942				568.8	\$6.5 70		66.9 TO 76.0 FT LINESTONE AND CHERT WHITISH GRAY(N7). SLIGHTLY WEATHERED. HARD. LOCAL LENSES AND INTERBEDS OF LIGHT GRAY(N7) CHERT 8.2 TO 0.4' THICK. STYLOLITES CAN BE OBSERVED. MODERATELY	
	5.0	4.	98x				560.7	75		FRACTURED.	
			SPOOL STA				SITE			NORTH END OF ASH POND DAM	COURT-5



96ET MA. PROJECT GEOLOGIC DRILL LOG CMT-5 FLISRAP - WELDON SPRING SITE M50+201 3 # 3 WATER PRESSURE SAMPLE TOPE
AND DAMETTER
AND DAMETTER
LINGTH CONE NAM
SAMPLE RECOVERT
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RECOVERT ENTER ON OUTER LEVELS, OUTER SETURA, ORDANCTE: OF TESTS 1 RESORPTION AND CLASSPICATION ELEVATION PAESEURE P.E. A = 2 MALLINA, ETC. 560.7 NXB 559.7 76 BOTTOM OF BORING AT 76.0 FT. REAMED TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 65.5 TO 75.5 FT. AP-AVERAGE LENGTH OF CORE FOR EACH RUN. LP-LONGEST PIECE OF CORE FOR EACH RUN. ROD-ROCK QUALITY DESIGNATION. COLOR CODES FROM ROCK COLOR CHART. GEOLOGICAL SOCIETY OF AMERICA, 1948. AR TON SS-SPLIT SPOON STIPSELBY TUBE! 94-5 NORTH END OF ASH POND DAM PROBLEM PRICES OF STHER



MALECT -MET IN GEOLOGIC DRILL LOG FUSRAP - WELDON SPRING SITE 14501-201 GW-6 1 # 2 SITE COOPERATES WEST OF FROG POND N101,223 W49, 852 90 COMPLETED DELLER DAIT MAKE NO RODET נוס משע MA 671 TRIAL BEPTO GEOTECHNOLOGY 6/26/86 7/21/86 KURT JAEGER **CNE-45** 61/3 224 42.3 65.557 COME MECONOMICTATO COME BOXES ID. TOP OF CASES MOUND EL. BEPTINEL GROUND BATTER EPTIME. THE OF MICK 43/943 5 (This 633.8 301/603.7 22.557/612 SAMPLE MANER SCHOOL/FALL CASING LETT IN HOLE DILABORTH LOSGED BY: HO LBS/30 N 2/685 L E RABER MATER SAD NO THERES

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AND MARKET SAD NO THERE SAD NO THERE SAD NO THERE SAD NO THERE SAD NO THE SAD NO PRESSURE SAMPLES APPLE TESTS Parter LOC MATER LEVELS. 1 **DLEVATION ELECTRON AND CLASSIFICATION** -METER OF 1 8=3 LER. ETC. ٥ 8.223 0.0-0.5 FT GRAVEL AND CLAY(GC), LIGHT 0-22.6 FT DRILLED **633.3** 10.5 ₹SE BROWN (5YR 6/4) TO YELLOW BROWN (10YR WITH 6 - IN OD NOL 5/4). SILTY CLAY WITH ANGULAR FRAGMENTS LOW STEM AUGERS 6.9 OF LINESTONE AND CHERT, LOW PLASTICITY, USING CENTER PLUG DRY TO MOIST. <u>ss</u> 18 2\* 5 D. S. F. T. STILLY CHAY(CO). YELLOWISH 0-10.0 FT BORE -17 8 9 BROWN, (10YR 5/4) TO YELLOWISH ORANGE HOLE WAS RADIO-5 (10YR 6/6). STIFF. NEDIUM PLASTICITY. LOGICALLY LOGGED HSA MOIST, MOTTLED, TRACE LINST, GRAVEL BY EBERLINE • AND HODULES. TRACE FINE SAND. ANALYTICAL ڡ **CORPORATION** 11.5 FT 700K 13 18" 26 6 15 11 SHELBY TUBE 10 SAMPLE ž 22.6 FT AUGER REFUSAL 51 24 23 96× 22.6 FT PERFORMEN 3 INTERFACE \$\$ 2 PERMEABILITY TEST 619.8 18" 5° 27 6 21 11 14.0-22.6 FT GRAVELLY CLAY(GC): BURL INGTON/ 15 YELLOWISH ORANGE (10YR 6/6). STIFF. KEOKUK FM ¥S. MEDIUM PLASTICITY, MOIST, ANGULAR RUN +1 FRAGMENTS OF LIMESTONE AND CHERT. 6.9 ROD - 28% LINESTONE FRAGMENTS OCCASIONALLY AP - 0.2 FT HIGHLY WEATHERED TO PONDERY CONSISTENCY, \$\$ 2\* LP . 0.4 FT 18" 11. 17 8 5 12 RUN #2 20 HSH. 100 · 782 AP . D.4 FT 1.9 LP = 1.0 FT 22.6 611.2 RUN #3 22.6-58.1 FT LINESTONE. LIGHT BROWNISH ROD . 0 X GRAY (5YR 4/1) TO YELLOWISH BROWN 13.357.85 85X AP . 0.1 FT (10YR 5/4). MODERATELY TO SEVERELY 25 WEATHERED WEDILM HARD TO HARD. CLOSELY LP . 0.2 FT RLN +4 FRACTURED. SOME FRACTURES WITH OXIDE ROD - 54% STAINING ALONG FRACTURES. CHERT LAYERS AND LENSES. VUGGY. VUGS AT: 32.6': AP = 0.2 FT LP = 0.7 FT 33.1': 33.6' 4,514.5 100x 6/27/86 30 22.6-65.5FT CORED RLN+3 51 (4) 11 11 177 WITH NOOR WIRE-LINE DIMOND IM-PRECNATED BIT 5.014.9 282 USING WATER LOST CIRC. 25.0FT 598.8 10 7 HD SS-FFLIT SPOON STI-SHELBY TUBE PRESENTAL PAPER DERIGO DESTRETA CH-E WEST OF FROG POND



	G	Ε	0L	OGIC	DRIL	l l	.0G	P	D.ECT	FUSF	WP	- WELDON SPRING SITE M501-201 2	er 2 GMV-6
SAMPLE TITE PO GAMETER	MIN MOD	S CONTRY	ECOVERN	W CENT CONE	P	MATER MESSUPE TESTS		ELEVATEN	HL 408	961 JH	SMFLE	RESERVITION AND CLASSFICATION	MOTES ON ONTEN LEVELS, ONTEN METABLE
3 2	ADD HISHED	1	100	MERCENT MERCEN	1000 1000	13.4 13.4	¥ = 5	5 <b>94.</b> 8	35	BETTE	•		MALLON, ETC.
					0.05	10	5						
					0.04	20	10		-	宁		37.2 - 38.7 FT BRECCIATED ZONE. ANGLAR CHERT AND LIMESTONE FRAGMENT IN	
	5.0	ļ.	75	<b>9</b> 5x	0.02	10	10			出	<b>S</b>	A NEDIUM GRAY(N5) CLAY ZONE.	
,									40	렆			
	_	╀						]			┝		का द्वा द्वा द्व
					0	10	10			迚	چ		
	5.0	٦	. 0	1002	0.9	20	10			占	\$		7 8.1 8.2 8 8 8.3 8.8 62 9 8.3 8.6 55 10 8.4 8.7 76 11 8.5 1.3 71
<u></u>		ŀ	-		0	10	5		45	护	_		11 0.5 1.3 71 12 0.4 0.9 69
3 CORE	.5	ŀ	5'	100%					.		7	47.3 - 47.8 FT HIGHLY FRACTURED AND	
æ	4.0		,	1002				1		扫	•	MEATHERED ZONE 47.3 TO 47.8 FT. NOTE SONE FOSSILS ON LIMESTONE FRAGMENTS.	
	7.0			1002					50	#			
	1.0	1	. 0'	1002						开	9		
		T								开			
										弄	7.		AP-AVERAGE LENGT
	5.0	4	.41	88%					55	王			RUN. LP-LONGEST PIECE
	-	+			-					井	4	-	OF CORE FOR EACH
								575.7	58.1		1  -		ROD-ROCK QUALITY
	4.5	<b>3</b> ' 4	1.5'	1002								58.1 TO 65.5 FT <u>LIMESTONE</u> , WHITISH GRAY(N8). SLIGHTLY WEATHERED. HARD.	DESIGNATION.
					]	ļ			60	#	7	MODERATELY FRACTURED, LOCAL LENSES OR FRAGMENTS OF BROWNISH GRAY(5YR 4/1)	COLOR CODES FROM
										弄	٩,	CHERT, PRESSURE SOLUTION CREMULATIONS	ROCK COLOR CHART
	4.5	5 /	1.5'	1002						莊		(STN.QLITES).	OF AMERICA, 1948.
		1						568.3	65	王	T E		_
		1						365.3	65.	7	T	BOTTOM OF BORING AT 65.5 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED	
								i		4		2-INCH 316L STAINLESS STEEL MONITORING	
:										4		MELL SCREENED FROM 55.5 TO 65.5 FT.	
										7			
										1			
										4			
										3			
	-			POON STA				SITE				WEST OF FROG POND	INDIT NO



	<del></del>		
GEOLOGIC DRILL LOG	FUSRAP -		or 3 DW-1
PATROL ROAD WEST OF COAL STORAGE		), 928 W50, 933 90	CRIZ. CARING
EGUN COMPLETED DRILLER GEOTECHNOLOGY INC.	DRILL HAVE CHE 75	,	FT.) TOTAL DEPTH 94.0'
CORE RECOVERY(FT./X) CORE BOXES SAMPLES EL. TO 32.4/93 4 13	P OF CASING GROU	49. D 48. 8' /600.2	59.0'/590.0
SAMPLE HAMBER METONT/FALL CASING LEFT IN MOLES 140 LBS/30 IN 2°/94.	DIA. ALENSTH	LOGGED BY:	
US EL WATER		RIAIRIDAICIGUES	
MAC STATE AND DIAMETER AND DIAM	PRAPITE LOB	DESCRIPTION AND CLASSIFICATION	MOTES SHI MATER LEVELS, MATER METURY,
	1 1 - 1		BRILLING, ETC.
157 8' 300 8' 500 8' 649. 0	0.5	D TO D.5 FT GRAVEL, LIGHT GRAY(N7)	0-59.0 FT DRILLED
\$ 1 P	] ]	LIMESTONE IN BROWNISH BLACK(SYR 2/1) TO BLACK(N1) FLYASH MATRIX.	LOW STEN AUGERS
		D.5 TO 11.D FT CLAYEY SILT, MOTTLED BROWN AND GRAY(10YR 5/4 TO 10YR 4.5/5),	USING CENTER PLUG
SS 18' 17' 15 5 6 9	5 7	STIFF, DXIDIZED NODULES.	
₹			
±			
SS 18 2 10 4 4 6	] ]   5		D TO 10.0 FT BORS
	10 -		HOLE WAS RADIO- LOGICALLY LOGGED
638.0	<b>│''</b> ╡║╟ <u>-</u>	11.0 TO 17.0 FT CLAYEY SILT. MOTTLED	BY EBERLINE ANALYTICAL
S1 24 26 26 26 26 27 28 28 28 28 28 28 28 28 28 28 28 28 28	1 11115		CORPORATION.
SS 18° 18° 18 5 6 12	15 -		
₹ £ 632.0			
S32.0	17-	17.0 TO 22.0 FT SILTY CLAY, GRAY AND	
SS 18" 19" 14 5 6 8		TAN(10YR 5/4), SOME FINE-GRAINED SAND, MANGAMESE OXIDE STAINING.	
7 7 7 7 7 7 7	20		
¥	2		
.9	1 411111	22.0 TO 46.0 FT CLAYEY SILT, VERY STIFF SOME FINE GRAINED SAND, OCCASIONAL	
SS 18° 22° 29 12 12 17	25 -	ROUNDED PEBBLES, BLACK(N)) MANGANESE OXIDE STAINING AND HEALING OF FRACTURES	
<b>5</b> 5		15 COMMON. 23.5 TO 25.0 FT DARK YELLOWISH GRANGE	
۵ ا		(10YR 5.5/6).	
SS 18 23 29 10 12 17	]	28.5 TO 30.0 FT YELLOWISH ORANGE	
	30 -	10YR 5.5).	
8. HSA			
		_	
SS 18° 26° 27 14 12 15 614.0	25		HOLE NO.
SS-SPLIT SPOON; ST-SHELBY TUBE; S-SENOTSON; P-PITCHER; 0-OTHER	PATROL	ROAD WEST OF COAL STORAGE AREA	GAY-7

A-60



	G	EOL	OGIC	DRIL	LLL	.0G		ROJECT	FUSR	ΔP	- WELDON SPRING SITE JOB NG. SHEET 14501-201 2	NO. HOLE NO. GMW-7
AND DANKTER	SAMPLEN ADVANCE	RECOVERY RECOVERY	SAMPLE BLOWS TO PEPCENT CONE RECOVERY	•	WATER MESSURE TESTS	T	ELEVATION	DEPTH	CHAPHIC LOG	SAUPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, OMRACTER OF
A CA	LENGT.	SAME	SAMPLE PEPERNT PECON	Σ≅ ξ Σ ε ξ	PRESSUR	THE SE	614.0	35	85			DRILLING, ETC.
6 HSA											38.5 TO 40.0 FT YELLOWISH BROWN	
\$5 2*	18*	24"	2?	10	11	16		40 -		88-B	(1DYR 5/), HIGHER PERCENTAGE OF CLAY.	
6 HSA											43.5 TO 45.0 FT MODERATE YELLOWISH	·
SS ? <b>'</b>	18"	20"	12	4	6	6		45 -	11111	58-9	BROWN(10YR 5/4), OCCASIONAL ROCK FRAGMENTS, VERY MOIST, DARKER BROWN (10YR 3/3) FROM 44.7 TO 45.0 FT.	
6. HSA							603.0	46			46.0 TO 59.0 FT GRAVELLY CLAY, ORANGE BROWN(10YR 5/6), AND ANGULAR, YELLOWISH WHITE(10YR 7/3)CHERT.	7/9/86
55 2°	18"	20'	57	21	29	28		50 -		55-10		<del>*</del>
6. HSA												
SS 2"	18"	16*	30	: <del>E</del>	16	14		55 -		SS - 11		·
D HSA											58.5 TO 58.7 FT ROCK FRAGMENTS IN WET BROWN(10YR 4/4)MUD.	59.0 FT AUGER REFUSAL. INTERFA PERMEABILITY TES PERFORMED AT 59.
H\$A	2	2	50/2	50/2	-		590.0	59 60 -	Y A	12	59.0 TO 69.0 FT LIMESTONE, YELLOWISH	FT. BURLINGTON/KECK
X5 3*	5'	4.4	85%							FUN •1	BROWN(10YR 5/4), MODERATELY WEATHERED SLIGHTLY HORIZONTALLY FRACTURED, WITH GRAY(N6), HARD CHERT FILLED VOIDS UP TO 4 INCHES THICK, CORE IS 30 TO 40%	FM. 55.0 TO 54.7 FT CORED WITH NXB WIRELINE PIAMOND IMPRES-
				0.016	1	5		65		2.	CHERT, SOME FRACTURES ARE CLAY FILLED.	NATED CORE BIT USING WATER.
XB 3"	5'	4.5	90%	0.002	20	5				€ NO.		
XB	5'	4.6'	92%				580.0	69 70 -		RUN +3	MODERATELY HARD, SLIGHTLY FRACTURED,	
	~~		onnu et en	FIRV TO	<u> </u>	1	574.0	75			STYLOLITES.	HOLE NC.
			POON; STESH REPITCHER						PATRO	)L	ROAD WEST OF COAL STORAGE AREA	GNH-7



	G	EOL	OGIC	DRI	LLL	.0G		DEC1	FUSI	EMP	- WELDON SPRING SITE M50+201 3	er 3 CAM-7
PLE TIPE BARETER	F 4744	E HECOMENT	ME MOUS W Zent done Econery		MATER TESTS		BLEVATUM	Ē	MATHE LOS	SAMPLE	BESCRIPTION AND CLASSIFICATION	MATES ON BATER LEVELS, BATER RETURN, COMMICTER OF
38		NOTE OF	3 E.	1083	15'd Mikkima	T BE STATES	574.0	75	8			BEALTHE, ETC.
NOCE 3"	5'	4.5'	90x							RUN 64	78.4 FT STYOLITE. 78 - 79.9 FT LINESTONE WITH NO CHERT.	
NXB 3'	5'	4.9'	<del>98</del> X					•0		MUN 45	BD. 0 STYLOLITE.  B2 - B4 FT LINESTONE BECOMES CLAYEY, SOFTER.  B4 - B9 FT THIN ZONES OF CLAYEY,	MUR (FT) (FT) (X) 1 0.15 0.3 0 2 0.2 0.5 30 3 0.3 0.55 43 4 0.25 0.35 44 5 0.25 0.9 27 6 0.25 0.4 71
NXB 3'	5'	4.7'	94%					85		MUN *6	SOFTER LIMESTONE.  89 - 94 FT FEW FRACTURES FILLED WITH ORGANIC CLAY UP TO 1/4" THICK.	6 0.25 0.9 27 6 0.25 0.4 50 7 0.3 0.6 71
NXB 3'	5'	4.8'	967				555.0	90		FLN 97	93.5 - 94 FT COLOR BECOMES DARK BROWN (5YR 4/6). BOTTOM OF BORING AT 94.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 83.0 TO 93.0 FT.	
									***************************************		AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP=LONGEST PIECE OF CORE FROM EACH RUN. ROD=ROCK GUALITY DESIGNATION FOR EACH RUN.	COLOR CODES FROM ROCK COLOR CHART, GEOLOGICAL SOCIETY OF AMERICA, 1948.
			Poor ST-S				OTE		***************************************		ROAD WEST OF COAL STORAGE AREA	IRLE IID. SART-7



	GE	OL(	OGIC	DRIL	LL		COORDINATES	FU	SRAP	- 1	ELDON SPRIN	G SITE	14501	-201	HEET NO.  1 OF THE ROW HORIZ	
70	O FT	. NOR	TH OF	COAL S	TORAGE	i i	COOPDRATES			101,		0,659			90	TOTAL DEPTH
ZUN /23/	20.	COMP	.етер 25/ <b>8</b> 6	DALLE	<sup>R</sup> G	EOTECH	INOLOGY	DPSL	L MAK		₩00EL E-45	HOLE SIZE	OVERBURDEN 3L5		25.5	
		לער פא		CORE		SAMPLES		OF CASING	ø	ROUND		EL GROUND 9		. [		TOP OF ROCK 1.5'/588.4
<b>A</b> (		0/90	HT/FALL	<u> </u>	3	C LEFT B	HOLE: DA. A	ENGTH		619	LOGGED BY:	34.2'/	1.50			2373001
		LBS/3					21/58.51						AATKIN	SON		
AND DIMINETUR	LENGTH CORE RUM	CORE RECOVERY	보존통합	<b>PR</b>	ESSURE TESTS	The N	<u>ele</u> vation	MT-G90	GRAPHIC LOG	SMPLE	DESCR	PTION AND CLA	SSEICATION			MOTES ON WATER LEVELS, WATER RETURN CHARACTER OF DRILLING, ETC.
1	בוג	310		- 3	£ -	3	619.9	0.2	///	H	0 TO 0.2 FT	ASPHA: T			0	-31.5 FT DRILLED
ם אניי							<b>V13</b> (1)	4714			0.2 TO 7.0 BROWN-TAN-Y	T SILTY	CLAY, MOTT (5Y 4/4),	TLED , STIFF	·.   L1	ITH 6IN OD HOL- DW STEM AUGERS ITH CENTER PLUG
S	18"	4.	12	6	5	7				15						
-			-					5 =	//	1						
HSH							612.9	7 -			7.0 TO 17.0	FT CLAYE	Y SILT, M	OTTLED		
5	18"	13°	29	5	12	17				52-52	ORANGE (10YR FINE-GRAINE	1476) AND DISAND AN	GRAY(5Y D GRAVEL.	7/1), ! BLACK	(	) TO 10.0 FT <b>BOR</b> HOLE WAS RADIO-
+	10							10		S	MANGANESE C	XIDE NODL	LES AND S	TAININ	S.   L	OGICALLY LOGGED BY EBERLINE
ž.										-						MALYTICAL
	12"		100%	-				-		15	12.5 FT BEG TO ORANGE (	DMING LIC DYR 5/6)	SHT BROWN( WITH ANGU	5YR 4/ Lar ch		CORPORATION.
\$	15"	1.5	91/9*	21	41	50/3	İ	_		1  2	GRAVEL.				-	
								15 -								
HSA							602.9	17 -			17.0 TO 31				RATE	
33.	5*	4.	50/5	50/5	<del>}</del>		1			4	REDDISH BR	3/4), WITH	H YELLOW!	SH ORAN	4GE	
								20 -			(10YR 7/6) GRAVEL.	TO MHITE	(N9) ANGU	AR CHE	RT	
HSA											UNATEL.					
SS 2'	18"	15"	<b>2</b> D	11	9	11	1	25								
<u>-</u>	1							25 -	<b>\$</b> */							31.5 FT PERFORM
HSA															ļ	PERMEABILITY TE THROUGH AUGERS.
SS 2"	18'	14*	33	5	20	13	-							·		PUMPED 5 GPM IN HOLE FOR 20 MINUTE WITHOUT FILLING
	┼	+	1	+	+	+	-	30	1		4					HOLE.
ν Υ Σ	-	-	<del> </del>	-		-	588.4	4 31.5		4	31.5 TO 5	.3 FT LI	MESTONE, E	BE I GE ( I	OYR	31.5 FT AUGER REFUSAL.
									井	H	6/4), MODE	RATELY WE	ATHERED,	MODERA	TELY	BURL INGTON/KEON FM
NXB 3"	4.0	2.9	73%				E04 5	35	开		HARD TO HE	JUES AND F	PATCHES.			6/25/86
	<u> </u>		P00% ST=			Щ_	584.5	2 1 22	ــــــــــــــــــــــــــــــــــــــ	ᅼ.	32.0 FT D	1220/11110	APPARIA			HOLE NO. GMV-8



£ 5	_	_	el l	OGIC		WATER TESSURE TESTS			POLECT	Γ			NO. SHEET 2	NOTES ON: WATER LEVELS,
AND DIMMETER	SAMPLER ADVANCE	LENGTH CON	CONE RECOVERY	FENCENT CONE RECOVERY	. 5 × 2	PRESSURE P.S.J	THE SECUES	ELEVATION 584.9	35	CRAPHIC LOC	SAMPLE	DESCRIPTION AND CLASSIFICATION		WATER RETURN, CHARACTER OF BRILLING, ETG.
		7						- 15A 15A		H	2.	36.0 TO 41.9 FT INCREASE IN	CHERT CON-	31.5 TO 57.0 FT
	2.1	0.	. 9'	95%	0.03	20	5		:		N.S.	TENT.		CORED WITH AN NXB WIRELINE
	1.0	<u>0. þ</u>	. 75	75%	0.66	28	5			H	3 R			DIAMOND IMPRE- CNATED CORE BIT
817				£ F.u.	0.20		5		. :	田	•			USING WATER.
		_1	. 1 '	55%					40 -		RG			
DIAMOND BIT	1.	0 1	1.85	85%					] :		-			
`		l								三	9			
RREL	4. (	0' 4	. 0'	100%	ĺ				:		P.S.	45.4 TO 50.3 FT OCCASIONAL	CAL CITE	
E 9/		+							45 -			FILLED YUGS.	CALCITE	
02					0.9	28	5							AP LP ROD 1 0.2 0.5 48
WIRELINE CORE BARREL	5.	0'	4. 8'	96%						吕	S.			2 0.2 0.5 42 3 0.75 0.75 100
WIR					0.3	20	5		:	1 1	₹			4 0.3 0.3 55 5 0.85 0.85 100 6 0.4 0.8 71
	_	4			<u> </u>			]	50 -		}_			7 0.3 0.4 52 8 0.3 0.5 57
		ļ						568.6	51.3		80	51.3 TO 57.0 FT LIMESTONE,		9 0.2 0.5 47
	5.	0'	5.0'	100%							· NS	FRESH, CHERTY, CRYSTALLINE, COATINGS ON FRACTURES AT 51		
										早		FT, AND 51.6 FT.	,,,,,,	
	-	1			-				55 -		_			
	1.	5'	1.5'	100%	-			562.9	57		5	BOTTOM OF BORING AT 57.0 FT	DEAMED	
										=		HOLE TO 8-1/2 INCHES AND IN	ISTALLED	
							1			7		2-INCH 316L STAINLESS STEEL WELL SCREENED FROM 45.5 TO		
									'	]				
										=			•	
									•	}				
										‡				
									'	]				
										1	.			ALL SOIL AND ROCK
									'	]		AP=AVERAGE LENGTH OF CORE P EACH RUN.	PIECES FROM	COLOR DESCRIPTION FROM THE ROCK COLO
										‡		LP=LONGEST PIECE OF CORE FR ROD=ROCK QUALITY DESIGNATION		CHART, PRINTED B
									'	7		RUN.	PET SHOT	SOCIETY OF
										<u> </u>				AMERICA, 1948.
										=				
									$oldsymbol{ol}}}}}}}}}}}}}}}}}$	1		·		
				P00N; S1=5				SITE		70	0 F	T NORTH OF COAL STORAGE AREA	1	HOLE NO.



	GI	OL	OGIC	DRIL	LL	OG		O.ECT	FUSRAF	> -	WELDON S	PRING	SITE	14501	-201		<b>a</b> 2	HOLE NO. CHN-9
TE 300	FT	NORTH	OF CO.	AL STO	RAGE /	<b>L</b> REA	COGROBATES		N	101,	350	<b>¥</b> 50	, 700		AFFELE	FROM H		-
6/25	/86		TLETED 16/86	DALLE	R GEO		LOGY INC. JAEGER		CM		/CME 750		10LI SEE	SO's		1	<b>33.</b> 5	TOTAL BEPTH 54.0'
PK I	ECOVE -L2	MET.J 2/33	20	COPE	noxes 2	SMPLE 5	2 6-10	- a cve	<b>**</b>	ROLDE 63	6.7	BEPTILLE	33.0°/5			MOPT IN	70. 100 0 20.5 F	
			DAT /FALL		CAS	<u>. மா</u>	N MOLE DAY	DETH			LOGGED BY	'è	.16	KASER/E. B	FBC: 11	MD		
1	HIU LL	LBS/	30 K		BATER .		2/01		1	П	<u> </u>			MACO L. E	LINE			
AND DAMETER	CONTRACTOR ADVANCE	Market 1 100	MENCENT COM		TESTS	THE STUDEN	ELEVATION	MEAN	Server 10c	SAMLE		NESCRIPTI	ZAJO GMA NO	seration			10 T	TES ON THE LEVELS, THE RETURN, PACTED OF LLBS, ETC.
┥	<b>~</b>	-		157 6"	<u>sc 1, </u>	380 € <sup>7</sup>	636.7 636.2	0.5	1//	H	0 TO D.	5 FT S	ILTY CLA	Y (QL).	LACK		0-20.	FT DRILLE
75 155		İ							<b>¥</b> ///		(N1) LO	W PLAS	TICITY.	MOIST. OF	KGAN 10	:S.		B IN OO HOL: TEM AUGERS
2						na na ili		'	<b>\</b> //	1				CLAY: LIG N (1 <b>5</b> R 4/			USING	CENTER PLU
35	18"	11"	10	3	4	6			<b>*///</b>	和	PLASTIC	ITY. S	OFT. MOI	ST. MOTTL	ED. L	.0-		
								5	<b>1</b> //	1				SILTY CL Fragments				
£									¥//	1	BLACK O	XIDE (	NI) STAI	NING.				
٥								'	1//		-							
Ş	18*	16°	23	5	10	13			<b>*//</b>	2								
HSA								10	<b>}</b> //	$\int$	10.0 FT	BECOM	ling more	BROWN				10.0 FT BOF WAS RADIO-
5T	24"	20.	83		ı		625.2	1.5		215				LLY CLAY			BY EB	ALLY LOGGEE ERLINE TICAL
55	18"	18'	39	6	17	22			*/	<b>4</b> <sub>3</sub>	BROWN	OR 3/4	(). MEDIL	M TO HIG	H PLA	<b>S-</b>	1	RATION.
2.		-						15	37	<b>}</b>				Y, LINES ILAR, GEN			11.5	T: SHELBY TU
HSA											1		OTTLED. I					
9							ļ										20.5	FT AUGER
SS 2'	5.	5.	50+	50/5"	-	-			*/	1	]						REFUS	AL.
<u> </u>							616.2	28.	5 1	1		·					INTER	
									#	Į. E				COMPOSED,			1	EABILITY TE CPM.
				-		-	$\dashv$		半	12	≥MODER/	ATELY I	HARD, WI'	TH LIGHT	CRAY(		B-D-1	NGTON/KEOKUK
3'	9'	3.3	37%						<b>7</b>	J	YELLOW	ISH OR	ANGE (10Y	8 8/6) CL	AY SE	NE.	1	
				15.4		5		25	出				CHERT G	RAVEL. STONE, LI	CHT C	RAY	_	TO 54.0 FT D W17H NOCE
				18.6	1	5	610.2	26.	5	#	(M5), I	ODERA"	TELY WEA	THERED, H	ORIZO	N-		LINE DIAMON EGNATED COR
				15.1	10	,			耳	1	LIGHT (	PAY(N	T), NARD	CHERT, U	P TO		-	USING WATER
		ļ	<del> </del>	<del> </del>	<u> </u>	-	607.7	29	-₹	Æ	<1/8 1	ICH DI	METER.	SOLUTION		Į	1	
								30	計	╬				HERT IN		SH	-	
NXB	10'	2.0	20x						五	工章	BROWN (	DYR 6	/4), YEA	HERED TO	LOCA	LLY		
3,	"		""						莊	7	WITH L	CHT C	RAY(N7),	HARD CHE	RT IN			
			<u></u>				601.7	35	#	#				AND NODUL IS BOX C				
_		CLINES	PODE STE	De 0=011			BITE.		30	0 F1			L STORAG				HELL II	C-W-3



RE	EOL	OGIC		WATER			O.E.CT			- WELDON SPRING SITE M501-201 2	or 2 GMT-9
SAMPLER AGYAN	COME METON	SAMPLE R. O.	1055 EP.M.	PRESSURE P.S.1	TAME IN IMMUTES	ELEVATION  60L7	₹ 18 35	SPAPPEC LOG	TI-MYS	BESCRIPTION AND CLASSFICATION	BATER LEVELS, BATER BETURN, CHARACTER OF BRILLING, ETC.
XB	0.6					582.7	40 -		RUN 64 RUN 43	43.7 TO 44.7 FT HIGHLY WEATHERED LINESTONE, CORE IS 70X CHERT 44.7 TO 46.5 FT LIGHT GRAY(NG), FRESH LINESTONE. 45.7 TO 46.0 FT CORE IS 60X CHERT. 46.5 TO 49.0 FT MODERATELY WEATHERED, CORE IS 50X CHERT.  48.5 FT OPEN FRACTURE, ORIENTED 60 OF FROM HORIZONTAL, IRON STAINED.  49.0 TO 54.0 FT RECOVERED ONLY PIECES OF CHERT.  BOTTOM OF BORING AT 54.0 FT. REAMED HOLE TO 8-1/2" AND INSTALLED 2 INCH 316 STAINLESS STEEL MONITORING WELL SCREENED FROM 47.6 TO 57.6 FT.	6/26/86  RUN (FT) (FT) (X)  1 0.15 0.45 68 3 0.15 0.45 16 4 <0.1 0.2 0
										AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP=LONGEST PIECE OF CORE FROM EACH RUN. ROD=ROCK QUALITY DESIGNATION FOR EACH RUN.	ALL SOIL AND ROC COLOR DESCRIPTIO FROM THE ROCK COLO CHART, PRINTED B THE GEOLOGICAL SOCIETY OF AMERICA, 1948.



	G	EOL	OGIC	DRIL	<u>LL</u>	.0G		DLECT F	USRAF	٠.	WELDON !	SPRING	SITE	1 450	1-201	SHEET I	<b>x</b> 2	CAN-10
TE.	400	FT P	IORTH O	FTRUC	K DOCK		COORDONATES				, 150	<b>¥</b> 50	, 100			90		•
9.84 /25	5/ <b>8</b> 6	1	/21/86	DARLL	DI CE		OLOGY INC. JAEGER	200			0 MODE. 5/CME 750	)	\$1/3°	32.8		max F	ינו נו	TOTAL BEPTH
	ECOVE	RIF .		COPE	BOKES	SMPU		F CASE	6 4		657 657	MOTIVE	40.07			BOTIL	L TOP 0	
<u> </u>		5/72 <b>D E</b>	DIT/FALL		3		BI HOLE DAVID	ЭБТН		•	LOSSED 5	Y				L		
_	140	LBS	30 N	1	NID:		2º/6/				1		715	JUSERVE	ENGLUM	) 		
E	Day No.	WOOMEN TO SERVICE	100 M		TESTS			¥	81	¥							_	
8	ומפנוא ממב אישונו ימו	300	MOD LIKEDHIM MOD LIKEDHIM MA MODEL TIMBET	2 - 4	7.	¥ = \$	ELEVATION	H-VD	guarac Los	3			<b></b>	CON CATION				SACTER OF LLBS. ETC.
•	319	30	M 18		200	30 5'		0	12	_	0 0 5	F7 65	DAVEL AM	N ~ AV 1 S	~ut 80/		N-32	B F7 DRILLI
40							641.6	0.5		$\lambda$	(5YR 5/	ार १व	TY CLAY		E TO C	OURSE	WITH I	SIN DO HOL
								:		1\				AY IS MOD Dist. <b>G</b> ra				TEM AUGERS CENTER PLI
<u>چ</u>				-	7	-				7.			D ANGUL	AR. CLAY LT.	<b>DE DO I</b>	CH CH		
•	18°	16*	17	3	-	10		5 -		}_	BROWN	OR 4/	6). ST1F	F, NEDIUM	PLAST	ICITY		
HSH.								:						IAY AND RE			HOLE	10.0 FT <b>BO</b> Was Radio-
9				İ						1	1		DXIDE ST G MORE R	AIN. ALSO EDDISH.	CHERT	•		ally logge Erline
SS	18"	18"	20	1	9	11	1	:	1//	1,							ANLY	TICAL RATION
2.		16		┼	-		1	10 -		7							-	NA: JON
Ŧ	_								<b>\</b> //	1								
ST 3"	24"	20"	83					-										
55 2'	18"	18'	26	7	11	15	1		<b>1</b> //	13								
	-			<del>                                     </del>		-	1	15 .	1//	1	1							
HSA I									<b>*//</b>									
.9					<u> </u>		_	'	<b>Y</b> //	1	18.5 T	0 18.J	5 FT LT.	. GRAY CL	AY INTE	ERBED.		
5 <u>\$</u>	18"	18"	19	13	8	111	623.3	18.8	1	34	18.8	0 32.	FISIL	TY CLAY D	ARK RET	HZIOK	RESI	DULUM Ft auger 1
¥Ş.							1	20	1//	1	MOIST,			ION PLAST	ici i i	31111	USAL	. PULLED B
± • 9									1//	1								r to 32.5   <b>Performe</b> d
		<u> </u>	<u> </u>	<u> </u>		<u> </u>			<b>Y</b> //	1	23 5 7	ი 25 (	FT MM	erous fra	EMFNTS	OF		RFACE PERM LITY TEST
\$\$ 2'	18*	10'	54	14	35	19		25	<b>Y</b> //	1:			O CHERT					GPM.
¥									*//									
•									¥//									TO 59.0 F Dusing NX
22		-	<del> </del>	+-	-	-	-		<b>*//</b>	4	-							LINE DIMO EGNATED CO
5, 22	18'	12	26		11	15	612.6	230	H	4	29.5	0 32.	FI LU	ESTONE, Y	ELLOVI	ŽÝ.	BIT	AND FRESH
\$									五	4	I N MAG	<b>CED</b>	MINH Y	FRACTURED	). WITH	i	WATE	.K. INSTON/KEOKU
.5	1_									<u> </u>	1			TH BARK I				
							609.3	32.	王	I	32.8	10 59. V15H B	0 FT <u>L18</u> ROMN(10)	ESTONE, D R 5/4), D	ODERAT ODERAT	TELY		
	<u> </u>		1		<u> </u>	1_	607.1	35	王	1	WEATH	RED.	MODERATE	LY HARD,	ORIZON	ITALLY	I I I	
				SHELDY T			#IL			4	100 FT M	ORTH D	FTRUCK	DOCK				CH-10



1	G	EOL	OGIC	DRIL	LL	.0G		ELECT	FUSF	WP	- WELDON SPRING SITE M501-201 2	er 2 CARV-10
DARTER	TOPE WENT	RECONDA	TE BLOWS	•	TESTS		ELEVATEM	E E	201 294094	SAMPLE	BESCRETTEN AND CLASSFICATION	MATER DIE BATER LEVELS, BATER METURIL SUBACTER OF
3 8		3	SAN SAN SAN SAN SAN SAN SAN SAN SAN SAN	77 (A)	DESTRUCTION OF THE PROPERTY OF	38 F	<b>507.</b> 1	35	1			STELLAND, ETC.
3°	יד	4.8'	69x					40		RUN ®!	FRACTURED, WITH LIGHT GRAY(NT) TO MEDIUM GRAY(N5), HARD CHERT INTERBEDS FILLED WOIDS, MODULES. FEW OPEN SOLUTION FEATURES, FRACTURES FILLED WITH DARK YELLOWISH GRANGE(6YR 6/6) CLAY WITH LITTLE SAND. 32.8 TO 39.0 FT 80% OF CORE IS CHERT.	<b>\$\frac{1}{4}</b> 6/27/86
NXB 3*	10'	7.2'	722	13.1 15.2 12.2	10 20 10	5 5 5		45		RUN *2	39.0 TO 49.0 FT 40X OF CORE IS CHERT, FEW FRACTURES ARE IRON STAINED.	AP LP 800 MAR (77) (77) (72) 1 0.25 <.1 55 2 0.5 0.25 18 3 0.5 0.15 30
NXB	10'	7.35	74x					55		RUN #3	49.0 TO 59.0 FT SLIGHTLY NORE FRACTURES, SOME FILLED WITH UP TO 1-INCH CLAY SEAMS, CORE IS 40% CHERT, FEW FOSSILS NOTED IN CORE.	
							583.1	59			BOTTOM OF BORING AT 59.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 48.0 TO 58.0 FT.	
									***************************************		AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP=LONGEST PIECE OF CORE FROM EACH RUN. ROD=ROCK GUALITY DESIGNATION FOR EACH RUN.	ALL SOIL AND ROLL COLOR DESCRIPTION THE BOOK COLOR CHARL PRINTED IN THE GEOLOGICAL SOCIETY OF AMERICA, 1948.
-	534	ו זיים	P004 574	HELET T	URE.		SUE .		<u> </u>	1_	100 FT NORTH OF TRUCK DOCK	MATE NO.



π			OGIC			OG	COOPDONTE	PROJECT S	FUSRA		WELDON S			1450)	-201	FROM HE	<b>cr</b> 2	GW-11 EADG
· ·	50 F	-	RTH. OF								,916		, 030	1	<u></u>	90		
6/26	/85	1	/18/86	DPLLS	- (		HNOLOGY NC.				10 MODEL 57/CME 75	1	6,\2, NOT. 202	32.0	-	NGC F	570 17	TOTAL BEPTH
OPE A	_	तहा <i>उ</i> 1/90		COPE	BOXES 5	SAPLE 7	3 61.10	OF CA	SONG C		0 gr	<b>EPTIVE</b>	. Chause 6/ 52.0*/6			BOTH	EL TOP 0	
ALF'LE	_		BIT/FALL	_l			N HOLE DA.	ALDETH		•	rosses su		32.076	œ.		<u> </u>	32.07	<b>b</b> ZEU
	140	LBS/	30 N	_			2/16	_	<del></del>	<del>-</del>			<b>A.A.</b> 1	TURSON/ELB	ERGLU	NO		
AO PARETTA	LIDETH CON RUN	CONT. M. CONTRY.	SAMPLE BLOWS  W  FUNCTOR COM  RECOVERY	1085 17 K	ESSURE TESTS	ă = 2	ELEVATION	MEPTH C	SOFT TOO	SAMIE	•	ESCHP TI	DI AND CLAS	SFEATON			98.1 98.1 CM	THUT ELC. BY VELTON' BY VENCT' BY CAST
P. HSA				1 <b>51 A</b> *	<b>20 1</b>	<b>300</b> 8°	653.0	0	11111			D GRA		LT, MCTTL .5/3) WIT		/CK	FOM 2.	D FT DRILLI SIN OD HOL- TEM AUGERS CENTER PLI
\$\$ ?*	18"	15°	12	6	6	б		5	1	1-55								
F HSA							647.0	6		 	GRAY, B	ROWN, IFF, M	AND ORAN DIST, BL	CLAY, MOT GE, STIFF ACK MANGA SIONAL RO	TO Wese	)		10.0 FT <b>BO</b> WAS RADIO-
ACH 0	18"	17*	34	5	6	8	,	10		-55	PEBBLES IRON OX	AND S	AND GRAI	NS, NODUL OW 23.0 F	ES DF		LOGIC BY EB ANALY	ALLY LOGGE ERLINE
2	24'		19	б	8	11		15		58-3 51-1			FT(10YR FT(5Y 5/					
E E	18*	• • •	20	,		10			1//	1	18.5 TO	20.0	FTCIOYR	5/6)				
6. HSA	10	13	20	7	8	12		20		SS	23.5 TO	25.0	F1(1 <b>0</b> YR	5,5/5)			32.0	Ft auger b
\$\$ 2'	18*	24'	22	9	10	12		25	1/					-,-,-,			USAL, INTER	PERFORMED FACE PERMI
A HSA				·			<b>6</b> 26.0	27	<b>3</b> //					LLY CLAY				
2°	4'	5*	50/4"	50/4*	-	-		30			MATRIX SILTY C	DF DRU	UNGE-BRON	HERT GRAV IN (10YR 5. ((N!) MAN	/5)		CORED VIREL IMPRE	TO 74.0 F LESING NXI INE DIAMO GNATED BI RESH WATE
9							621.0	32			TO MODE	RATE '	ELLOWISH ATHERED	STONE, LIGHT BROWN(), HARD, M	OYR 5. ODERA	/4) Tely	1	NGTON/KEO
			CON STESH			<u> </u>	618.0 me	35	<u> </u>		HORIZON FT NORT			D, WEATH	<u>ERING</u>		HOLE (SE	Ger-11



	G	EOL	OGIC	DRIL	LL	.0G	<u></u>	O.ECT	FUSI	W	- WELDON SPRING SITE M501-20	2 07	
DO CHARTER	DOM NO.	COVERY	F R OFF	•	MATER MESSLAW TESTS		ELEVATION	TL GEOTH	8012	SAMPLE	DESCRIPTION AND ELASSIFICATION		METEL ON BATER LEVELS, BATER METURAL
9	LOCAL CONT	3100	ADULA ADULA ADULA	1885 E # 2	27.4 27.4	¥ = \$	<b>SIR.</b> D	35	ž	3			DWALTER OF STALLER, ETC.
3. IXB	7'	6.6	94%			·				PEN	INCREASES WITH DEPTH, WITH LIGHT GRAY(N7), HARD CHERT INTER AND FILLED WOIDS UP TO 3-INCHES DIAMETER. FRACTURES ARE FILLED W YELLOWISH GRANGE(10YR 7/6) CLAY. 34.0 TO 35.0 FT CLAY SEAM.	IN I	AP LP 000 L0 (F1) (F1) (Z) 1 0.95 0.35 51 2 1.2 0.35 51 3 0.7 0.25 43 4 0.5 0.25 23 5 0.45 0.2 33
XB	10'	9. 1'	912				610.4	42. <del>6</del>		RUM •2	35.0 3-INCH LAYER OF DECOMPOSED STONE. 36.0 3-INCH LAYER OF DECOMPOSED STONE. 39.0 TO 42.6 FT 80% OF CORE IS C FILLED VOIDS. 42.6 TO 69.3 FT LIMESTONE, YELLO BROWN (10YR 5/4), SLIGHTLY WEATHE HARD, HORIZONTALLY FRACTURED, WI OCCASIONAL LAYERS OF LIGHT GRAY(	HERT WISH RED, TH	
XCB								50		•3	CHERT MODULES MAKE-UP 20% OF COP OCCASIONAL VUGS (UP TO3/(INCH), F FOSSILS. 46.3 TO58.0 FT 50 TO 70% OF CORS CHERT.	E,	<u>6/30/86</u>
3"	9'	7.5'	83x	19.2	10 20	5		<b>5</b> 5 ·					
NXB 3'	9'	7.5	83x	18.4	10	5		65				Į.	P-ANERAGE LENGTH OF CON IECES FROM EACH RUN. P-LINEEST COME PIECE FI IN-MOSE COME TY DESIGN- THON FUR EACH ROM.
3°	7'	7.0	100%				583.7	69.3 70	٦		69.3 TO 74.0 FT LINESTONE, OLIVI (5Y 6/1) SLIGHTLY WEATHERED, HAI HORIZONTALLY FRACTURED, WITH NEI BLUE GRAY(5B 6/1), HARD CHERT F, VOIDS, GOX OF CORE IS CHERT. 70.7 FT HORIZONTAL FRACTURE SUR COATED WITH BLACK(NI) ORGANIC N	ED, DIUM ILLED FACE ATERIAL.	
							579.0	74			BOTTOM OF BORING AT 74.0 FT. RE HOLE TO 8-1/2 INCH AND INSTALLE 316L STAINLESS STEEL MONITORING SCREENED FROM 62.8 TO 72.8 FT.	2-1NCH NELL	COL AND MICK COLOR MES PYTOMS FROM THE MICK OLOR CHART, PROMITED MEMORISE CAL SOCIETY MEXICA, 1944.
			PODE STA				SITE			-	SO FT NORTH OF TRUCK DOCK		GANT-I



ITE	Gl	EOL	OGIC	DRIL	<u>L</u>	.0G	COORDONATES	ROJECT		-	WELDON !	PRING	SITE	JOB NO. 14501	-201	SHEET FROM H	of 2	HOLE NO. GMW-12 BEARING
			H OF FR			, <u>.</u>					050	<b>W</b> 49	,643	1		90	<u></u> .——	TOTAL DEPTH
EGUN 5/26	/86	1	PLETED /17/86	DRALLE	DR I		HNOLOGY NC.		MOBIL		) woder 7/CME 75	0	HOLE SIZE	OVERBURDEN 25.5		ROCK 6	34.5	60.0
ORE R		767J	′α	COPE	BOXES 4	SAMPLE 6	S EL TOP	OF CA	SING GF	OUNC 63	6.2	DEP TH/E	26.09/61			DEPTH/	TLL TOP 0	
AMPLE	HALE	DR WE	GHT/FALL				N HOLE: DIA./L 2º/6L0'	ENGTH			LOCCED BY	<u> </u>		KINSON/E.B	ERGLUN	1D		
		E			WATER		2,,,,,				1					,	MOT	TES ONE
NO DANETER	CORE	RECOVER	SAMPLE BLOWS  "W" PENCENT CORE RECOVERY		TESTS		ELEVATION	100	PAPHIC LOG	SAMPLE	!	DESCRIPTI	ON AND CLAS	SFICATION			WA'	TER LEVELS, TER RETURN, VRACTER OF
3 8	SAMPLEN ADVANCE LENGTH CORE RUN	CORE RECOVER	PERCE PERCE	15 E 38	15.7 P.	ME STORES	636.2	0	CRAP							İ		LLMC. ETC.
				181 8	- AU -	×.	000.2	1	4					T, BROWN				5 FT DRILLER 61N DO HOL-
6 HSA									<u> </u>		TIOIN 4	/ Z I , F	EUTUP: 31	irr, Muis			LOW S	TEM AUGERS
				•	<u>:</u>				4							:	asino	CENTER PLUC
SS 2"	18*	15"	10	3	5	5		5	<u> </u>	-55								
HSA							630.2	6	1		6.0 TO	20.0 F	T SILTY	CLAY, MOT	TLED			
.9									1//					R 5/6), M OCCASION				
SS 2*	18"	16"	12	5	6	6			1//	S-2	(N1) MA	NGANES	E OXIDE	FILLINGS, IRON DXID	SAND		о то	10.0 FT <b>BO</b> R
ST	18"	16"						10	1//	-15	5122 110						HOLE	WAS RADIO-
3'	10	10							1//	ST							BY EB	ERLINE TICAL
HSA									1//		13.5 TC	14.7	FT(10YR	4.5/3).			1	RATION.
SS 2'	18*	17*	37	4	6	31		15	1//	55			FT WHITE	(N9) ANGL	JLAR C	HERT		
HSA									3//		FRAGMEN	Π.						
H .9			•						1//									
\$\$ 2 <b>"</b>	18*	16*	8	6	4	4			1//	S-4			FT(10YR HERT FRAG	5/5) DCC/ MENTS.	ASIONA	<b>AL</b>		
							616.2	20		5	20. D TO	25.5	FT GRAVE	LLY CLAY,	BROV	N.	1	
HSA									3/2		(10YR 4	1/3), [		H WHITE(			1.	FT AUGER SAL, PERFORM
٠.	40	4"	50/4"	50/43		ļ			3/	1.5	PATOOL IV						INTER	RFACE PERM- LITY TEST.
SS2 <b>'</b> '•	4"	1	30/4	30/4		<del>  -</del>		25	3/									INGTON/KEOKU
<b>-</b> =		_					610.7	25.	5##	_				TONE, DUS		LLOW	7	7 FM. -7/18/86
NXB 3°	3.5'	3.2'	91%						盐	* **	MODERAT	ELY W	EATHERED,	MEDIUM I D. WITH I	HARD,		=	<del>,</del>
									迚		MEDIUM	LIGHT	GRAY (N6	CHERT I	NTERB!		CORE	TO 60.0 FT BXN DNIZU O
								30	出		AND VU	35, <b>S</b> 0	ME CONTAI	SOLUTION	Y FILI	LING	IMPR	LINE DIAMONE EGNATED CORE
NXB 3	5'	3.6	72%						盐	- S	WITH SO			CREASES OF			BIT .	AND FRESH R.
:										_   ₹	CLAY. 25.9 TO	29.0	FT CORE	IS 40% C	HERT.			
	-				}		601.2	35	一	+	33.0 TO	33.5	FT 6-IN	H DIAMET	ER VO	ID. H CLAY	,	,
			POON, STESS : PROTOLER			<u> </u>	TE.						OG POND				HOLE N	CMW-12



1XB 3 2 1XB 3 2 1XB 3 1	2' 3'	STANTE RECOVERY  1. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.	1 00%	LOSS	TATER RESSURE TESTS 380755304	THE IN IN IN IN IN IN IN IN IN IN IN IN IN	ELEVATION  601.2	35	SOVERIC LOG	RUN #3 SAMPLE	DESCRIPTION AND CLASSFICATION  35.7 TO 37.5 FT 2-1/2 INCH DIAMETER CHERT NODULES. 37.5 TO 39.4 FT CORE IS 70% CHERT.	MOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF ORALLING, ETC.  AP LP ROD RUN (FT) (FT) (%)
iXB 3 2	2' 3'	1.9' 3.0'	95%		•		60.2			, ,	CHERT NODULES.	AP LP ROD
3° 2′ NXB 3° 1	3' 1'	3. 0'						40	$\Box$			RUN (FT) (FT) (7)
3° 1	1'		100%			1	İ	":		RUN•4	39.4 TO 45.0 FT CORE IS 20% CHERT.	1 0.2 0.5 34 2 0.3 0.7 47
IXB .		0.65'	1	ţ						RUN*5		1 0.2 0.5 34 2 0.25 0.5 18 4 0.25 0.45 24 5 0.25 0.35 12 6 0.15 0.3 0 7 0.15 0.6 37 9 0.25 0.5 65
IXB		ŧ	65%					45 -	# <u></u>	9		·
	5'	4.9'	96%					50 -		RUN *7	47.6 TO 50.5 FT EXTREMELY WEATHERED ZONE.	
ixB	5'	4.9'	98%	.22	20	8	585.7	50.5		RUN •8		
NXB	5'	5.0	100%					55 -		RUN #9	EXTREMELY WEATHERED, SOFT, WITH MEDIUM BLUISH GRAY(58 5/1) CHERT FILLED VOIDS MAKING UP 40 TO 50 % OF CORE.	
							576.2	60 -	+		BOTTOM OF BORING AT 60.0 FT. REAMED HOLE TO 8-1/2 INCH DIAMETER AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 48.0 TO 58.0 FT.	
											AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP=LONGEST PIECE OF CORE FROM EACH RUN. RQD=ROCK QUALITY DESIGNATION FOR EACH RUN.	ALL SOIL AND ROCK COLOR DESCRIPTION FROM THE ROCK COLOR CHART, PRINTED BY THE GEOLOGICAL SOCIETY OF AMERICA, 1948.
			SPOON; ST=	1		1	SITE		<u> </u>	1.		HOLE NO.



PROJECT MEET ALL GEOLOGIC DRILL LOG ME F MA FUSRAP - WELDON SPRING SITE 14501-201 1 = 2 GM-13 COORDINATES MERIT FROM MORE. OUTSIDE OF FENCE NE OF BLDG. 404 N100,619 **¥49.** 539 90 COMPLETED DRLD DIELL MAKE AND MODEL 101 10H ONE BLAND FT TRIAL MEPTE **GEOTECHNOLOGY** 200 673 6/26/86 7/16/86 MOBL B-57 6./3 27.5 70.0 INC. 425 COPE RECOVERY 1/20 CORE BOXES SAPLES EL TOP OF CASAC HOUSE DL SEPTIMEL SPEAK SATE EPTILIEL TOP OF MICK 40,3/95 6 645.5 33.61/605.9 27.51/68.0 SAUFLE MANER SERVICEALL CASEC LETT IN MOLE DIA ALEXETH LOCOLD IT 140 LBS/30 N 2769.0 ALATKINSON/DJHARNESH BATER SAMPLE RECOVERY
SAMPLE RECOVERY
WESTONERY
RECOVERY MESSURE METES CO. SAMPLER APPL TESTS MITTER LEVELS SAPOLE T **ELEVATION** BESCRIPTION AND CLASSIFICATION BATER RETURN. 77. MALETER OF 645.5 0 TO 8.6 FT CLAYEY SILT, MOTTLED TAN 0-27.5 FT DRILLED ₹. AND GRAY(10YR 4/4), VERY SOFT. WITH BIN DO HOL-LOW STEM AUGERS • USING CENTER PLUG. 18' 5. 3 3 2 636.9 18" 14" 7 13 5 6 8.6 TO 17.0 FT CLAYEY SILT, MOTTLED 0 TO 10.0 FT BORE 10 STIFF, COMMON DARK REDDISH BROWN HOLE WAS RADIO-32 (10R 3/4) IRON NODULES. LOGICALLY LOGGED 8.6 TO 10.0 FT DARK GREENISH GRAY BY EBERLINE ST (5GY 3/1) TO OLIVE BROWN(5Y 3.5/6) ANAL YTICAL 19 24" CORPORATION. 13.5 TO 15.0 FT YELLOWISH GRAY(5Y 8/1) 18" 21.5 14 5 7 7 15 쟢 628.5 17 17.0 TO 21.0 FT SILTY CLAY, MOTTLED VERY STIFF, WITH WHITE (N9) SAND SIZED CHERT FRAGMENTS, OCCASIONAL BLACK(N))
MANGAMESE OXIDE STAINING AND FILLINGS.
18.5 TO 20.0 FT MOTTLED DRANGE(10YR 5/6) SS 18" 201 16 7 9 20 AND LIGHT OLIVE GRAY(5Y 6/1) 624.5 21 3 21.0 TO 27.5 FT GRAVELLY CLAY, MOTTLED YELLOWISH GRAY(5Y &/1) AND DARK YELL-DWISH ORANGE(10YR 6/6), VERY STIFF. ANGLEAR WHITE(N9) AND MODERATE YELLOW-18" 27 12 11 9 18 ISH BROWN (10YR 5/4) CHERT FRACHENTS. 27.5 FT AUGER TRACE TO SOME SAND. 圣 REFUSAL. BURL INGTON/KECKIK FIL • 618.D 27.5 27.5 TO 70.0 FT 27.5 TO 60.0 FT LINESTONE, PALE YELL-CORED USING NXB NXB 2.5' 2.2' BRY DWISH BROWN (10YR 6/2) TO LIGHT OLIVE WIRELINE DIAMOND INPREGNATED CORE GRAY(5Y 6/2), MODERATELY WEATHERED, 30 MODERATELY HARD, MICRITIC, VARIABLY BIT AND FRESH FOSSILIFEROUS, STYLOLITIC, ABUNDANT WATER. CHERT AS MODILES AND REPLACEMENT BEDS. 5.0'4.6" 92% RANGING IN COLOR FROM VERY LIGHT GRAY (N8) TO WHITE (N9), HARD. 610.5 HOLE HO. SS-SPLIT SPOON STI-SHELDY TURKS DUTSIDE OF FENCE, NE OF BLDG. 404 PRODUCEDLY PHOTOER OF THER BW-13



		G	EOL	.OGIC	DRIL		.0G		ROJECT	FUSR	AP.	- WELDON SPRING SITE JOB NO. SHEET 2	NO. HOLE NO. GMW-13	
SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	CORE PLA	SAMPLE RECOVERY CONE RECOVERY	SAMPLE BLOWS  W PERCENT COPE RECOVERY	WATER PRESSURE TESTS		ELEVATION	DEPTH	STAPHIC LOG	SANPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN,		
SAMP D CHA	SMPLE	LENGTH	CORE	SAMPL PERCE PEC	1055 F.F.	PRESSURE P.S.I	TARE MENUTES	610.5	35	CHAP	3		CHARACTER OF DRILLING, ETC.	
NXB 3"	5.	0'	4.8'	96%				·	40 -		RUN #3		7/3/86	
NXB 3°	5.	0'	4, 4'	88%	0. 07 0. 10	<b>2</b> 0	<b>5</b>		45 -		RUN •4	40.0 TO 48.5 FT CORE IS 50% CHERT.		
NXB 3°	5.	0'	4.8'	96%					50 -		RUN #5	49.0 TO 55.0 FT YELLOWISH ORANGE	RUN (FT) (FT) (Z)  1 0.1 0.5 29 2 0.2 1.1 47 3 0.3 1.1 55 4 0.4 0.8 50 5 0.2 0.8 30 6 0.3 0.5 12 7 0.2 0.7 13 8 0.3 0.5 60 9 0.5 1.9 84 10 0.3 0.6 72	
(XB3	1.	1	1.1'	100%							9	(10YR 7/6), 30 TO 40% OF CORE IS CHERT.	8 0.3 0.5 60 9 0.5 1.9 84 10 0.3 0.6 72	
3°	4.	0'	3.6'	90%					55 -		€ NOR	55.0 TO 60.0 FT CORE IS 50 TO 60% CHERT.		
NXB 3°	5.	. 0'	4.8	96%				585.5	60		RUN +8			
NXB 3°	5.	. 0'	5.0	100%	0.07	20	7 5	-	65 -		RUN #9	V2INCH VUG LINED WITH CALCITE, STYLOLITIC, INTERBEDDED WITH MEDIUM	APHAVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LPHLONGEST CORE PIECE FROM EACH RUN.	
3°	5.	. 0'	5.0	100%						二二	RUN •10	BLUISH GRAY(5B 5/1), HARD, CHERT.	ROO-ROCK QUALITY DESIGN- ATION FOR EACH RUN.	
								575.5	70 -			BOTTOM OF BORING AT 70.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH TYPE 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 58.0 TO 68.0 FT.	SOIL AND ROCK COLOR DESCR IPTIONS FROM THE ROCK COLOR CHART, PRINTED BY THEGELDOICAL SOCIETY OF AMERICA, 1948.	
				POON; STES				SITE		<b>9</b> U	TS	DE OF FENCE, NE OF BLDG. 404	HOLE NO.	



SITE		GEO	LOGIC	DR	ILL	LOG	COOPDONTE	PRO.EC		AP ·	WELDON	SPRING	SITE	14501	-201		<b># 2</b>	MOLE MA. COM-14
<b>X</b> 0			NER OF A	PARK							100,735	¥ 49,				FROM H		EARG.
6/	27/8		7/7/86				CHNOLOGY INC.		MOBI	L B	HO HODEL -57/CME75(	•	6.\2.	33.0		MCX F	FTJ NS_0	191AL BEPTH 59.0
l		B.7/7	6		S BOICES	7		-			₩ <u>₽.</u> 47.3	BP BVE	43.076				33.0/6	
			S/30 IN		CAS	<b>86 LET</b>	2º/59.0				LOSSED \$	T <sub>1</sub>	A. ATI	KINSON/ E.I	FRELU	<b>20</b>		
E E	Ā	5	E E		MATER MESSIA					T						<u> </u>		
2		St.	FRANCIS CON		TESTS	l b	ELEVATION	1	Dame 100	1		<b>IESCIP</b> TI	2AJO (BNA NO	SFICATION				is die Dr Levels, Dr Retigne
3 3	3	3	3 15-	2 Z	TO SEE SEE	2 2 5	647.3		8								COM Mal	METER OF LINE ETC.
6*HSA							646.8		=		0.5 TO	0 01H	ER ORGAN) I CLAYEY	BLACK(N) C MATERIA SILT, MOT	TLED		WITH 6	FT DRILLED IN OD HOL- EM AUGERS
\$\$ 2*	18	11"	25	4	15	10			<b> </b>	55-1	STIFF, S	) Brown Small	N(10YR 4. IRON OXII	5/3), NEC DE NODULES RAGMENTS.	TUM	- 1		CENTER PLUG.
6"HSA								5										
\$\$ 2'	18.	14°	7	3	3	4		10		2-55							0 TO 10	0. 0 FT <b>BOR</b> E-
₹.							636.8	10.5		$\prod$	10.5 TO	21.0 F	T SILTY	CLAY, MOT	TLED			AS RADIO- LLY LOGGED
<u>\$1</u> \$5	12							:		38	ISH DRAN	ICE (10)	R 5/6).	and dark some sand	SIZE	OW-	BY EBE!	
<b>S</b> S <b>2</b> *	18*	13*	26	15	9	17				22	DXIDE ST	S, AND RINGER	) BLACK (N IS AND F1	1) MANGAN LLIMGS.	ESE	ľ	CORPOR	ATJON.
6 HSA								15 -										
S2'	9.	9.5	50/3*	10	50/3*	-				T	66 A TA	<b>68</b> A F	T FEW TO	TH 20055	•-			
e.HSA							626.3	20 -			DECOMPOS	ED LIM 33.0 F	ESTONE.	IN ZONES	DARK			
S2	4"	6,	50/4"	50/49	-			=		Ш	EXTREMELY	Y WEAT	HERED, A	NGLLAR, VI FRAGHENT	RY P	ALE		:
75H.9								25			RANGING I	FROM P	EBBLE TO	SAND SIZE		f	RESIDUU	М
SS 2'	18.	13.	22	16	10	12				9								
6 HSA								30		SS						R	INTERF A	AUGER , PERFORMED CE PERM- Y TEST.
3°	2*	0.8	40x				614.3 612.3	33 35		NO.	SS. 0 TO 3 GRANCE (16 HARD TO INTERBEDS	5.0 FT 278 5/1 ED1UM	LINESTON	POSET AND A	LLOW! O'UM CHERT	SH a		TON/KEOKUK
	<b>-0</b> ()	IT SPO	ON STASHED	BY RUBE OTHER		art.					CORNER O		H PARKIN	G LOT		MO	CH TT INV	W-14



	G	EOL Ele	OGIC		MATER	.0G	1	O.ECT		w	- WELDON SPRING SITE M501-201 2	er 2 Gary-14
AND DAMETER	LONGTH COR.	COME RECOVE	SAMPLE BLOWS  WENCENT CONE	1055 Z	TESTS DE DE DE DE DE DE DE DE DE DE DE DE DE	TBAE BI BEATES	SLEVATION SEC.3	F 25	BRANC 100	BAMPTLE	DESCRIPTION AND CLASSFICATION	BATES LEVELS, BATES RETAINS BORNETER OF BRALDIN, ETC.
1008 3"	5'	3.3'	66%					40		RUN • 2	35.0 TO FT LINESTONE, NODERATE YELLOWISH BROWN (10YR5/4), NODERATELY TO SLIGHTLY WEATHERED, MEDIUM HARD, SLIGHTLY FRACTURED, WITH HARD, LIGHT GRAY (N7) CHERT FILLED VOIDS, HORIZONTAL FRACTURES CONTAIN CLAY	33.0 TO 59.0 FT. CORED USING NOOB WIRELINE DIAMOND INPREGNATED CORE BIT WITH FRESH WATER.
α8 3"	5'	3.5'	70x		i.					RUN•3	FILLING. 36.0 TO 38.0 FT CLAY SEAM. 40.0 TO 45.0 FT CORE IS 60X CHERT. 44.0 FT VUGS WITH QUARTZ AND	7/7/86
3°	5'	3.5	702	3.5 3.75 2.7	10 20 10	8 5 5		45 -		RUN•4	CALCITE CRYSTALS. 45.0 TO 49.0 FT FEW THIN ZONES WITH DECOMPOSED LIMESTONE AND ANGULAR CHERT FRAGMENTS. 49.0 TO 50.0 FT MEDIUM LIGHT GRAY	MP LP 000 MM (FT) (FT) (X 1 0.1 0.15 0 2 0.3 0.8 80 3 0.2 0.35 37 4 0.2 0.35 30 5 0.2 0.35 4 6 0.2 0.4 40
NXB 3"	5'	4.6'	927					50 -		R U N • 5	(N6) DECOMPOSED LIMESTONE WITH FRACTURED CHERT.  50.0 TO 55.0 FT MODERATELY FRACTURED WITH CLAY FILLING, CORE IS 30% CHERT.	
3, NXB	4'	4.0'	100z				588.3	55 -		RUN.6	56.0 TO 59.0 FT FEW THIN ZONES OF DECOMPOSED LINESTONE.	
											BOTTOM OF BORING AT 59.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL: SCREENED FROM 48.0 TO 58.0 FT.	
									lateritaren.		AP-AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP-LONGEST PIECE OF CORE FROM EACH RUN ROD- ROCK QUALITY DESIGNATION FOR EACH	SOIL AND ROCK COLOR DESCRIPTION FROM THE ROCK COLOR CHART, PRINTED BY THE
	<b>PA</b> -		POON STAS			10	in.		***************************************		RUN.	SECLOGICAL SOCIETY OF AMERICA, 1948.



	G	EOL	OGIC	DRI	LL L	.0G		ROLEC		P -	WELDON !	SPRING	SITE	14501	-201	1	or 3	MOLE NO. CMV-15
ACRI	oss i	INTER	RSECTION	FROM	BLDG.	412	COORDONATES		N	1100	0,100	W5(	,550		AMELE	FROM N		MEA/OG .
6/2			#LETED 5/30/86	DPLL	ER CE		IOLOGY IN	C.	DPLL MA		NE-45		6'/3"	OKREJED 45.5		ROCK (	77J 40.0	TOTAL BEPTH
ONE.		DITE 1.	<i>/</i> 10	COPE	BOXES	SMFL		OF CA	5000		10 D.		-				/D. TOP 6	
MP.	E MAN	e) e	DENT/FALL		CVB		N NOLE DA		•		57.4	Tı	53.47/6/	-			43.3 /	( <b>45</b> .)
	-		/30 N		BATER		2*/78.5*	Т	T	Τ	1			TE KAS	ER			
A TOTAL	Day MA	R COVERY	SAMPLE BLOWS  W  PERCENT CONE RECOVERY	•	TESTS	1	ELEVATION	E	PREMISE LOG	12		RECEPT	ION AND CLAS	NSEPCATION				MES COM TOPR LEVICLS, TOPR METINGAL
2 2 2 2	SAMPLER LEDGTH O	3	PERCENT RECENT	S = 3	TS'4	A PER STATE	657.4	0	1 -	=							_	MACTER OF LLBG, ETC.
HSA							656.9	0.5	_	1				AND CLAY!			1	5 FT DRILLE 6IN OD HOL-
1 .9									<b>3///</b>	<b>1</b> \		TH AN	LLAR FRA				LOW S	TEM AUGERS CENTER PLU
22		2°			_				<b>1</b> //	}_	0.5 TO	33.9 F	T SILTY	CLAY(CL)			ms inc	
\$\$ 2 <b>'</b>	18*	2	6	4	3	3		5	<b>\</b> //	1	PLASTIC	ITY. S	TIFF. MO	6/6) MED TTLED(WIT	H MED			
HSA									<b>*//</b>		TRACE L	INESTO	ME/CHERT	UTING TO FRACHENT	S AND	)		
9									<b>*//</b>		1			D SIZE). DEPOSITS		LY		
SS 2	18"	14"	12	3	5	7			1//	2								10.0 FT OLE WAS
HSA								10	1//								LOGGE	
ST	24"	23°	96						<i>\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\</i>	在							EBERL ANAL Y	TICAL
\$§ 2'	18*	16'	14	4	6	8	=		1//	3							CURPU	RATION.
								15	1//	7	1							
# HSA									¥//				•					
SS 2°	18"	N.R.	13	3	5	8			<i>\( \)</i>	1.	1							
\$S 2"	18"	1	5-7-10 17	5	7	10		20	<b>1</b> //	1=	20.0 FT	CLAY	BECOMING	STIFFER.				,
HSA									¥//	7	1							
\$\$ 2'	18"	18*	24	5	10	14			1	5	1							
HSA								25	1//	1	1							
¥ • 9									*//									
<b>5</b> S <b>2</b> '	18"	18"	31	10	17	14			<b>*//</b>	16	28.0 TO LOW PLA			INTERBEDE	D, W	OTTLEC	]	
HSA								30	1//	1	1				÷			
9 a H									1//		13 0 Tr	AR E	FT CRAVE	L AND CLA	١٧(تار	):	$\left\{ \right.$	
\$\$ 2*	5.	5'	50+	50/5"						<b>}</b>	YELLOW	SH OR	ANGE (10YF	6/6). SC	FT, L			
<u> </u>	22-13		CON STESH	ווד אנבם			622.4 m	<u> </u>		1	INTERSE						HOLE MO	GW-15



	G	EOL	OGIC	DRI	LLL	.0G		TOECT	FUSF	WP	- WELDON SPRING SITE	#50F20I	2	æ 3 wy	MOLE NO.
AND CHARTTER	LINCTH CORE NUM	CONE MICOVERY	SAMPLE BLOWS  WENCENT CONE RECOVERY	LIBSS N N-M.	BATER TESTS WATER	TAME BI BIOTIES	ELEVATION	NE ALE	STATUTE LOS	SMPLE	BESCHPTION AND CLASSIFIE	EATION .	-	941 941 000	TEL BIO TER LEVELS, TER RETURN AMOTER OF LING, ETC.
HŞA					E .		<b>522.4</b>	35	7		ANGLEAR FRAGMENTS OF LIG LINESTONE AND CHERT.	SHT CRAY(NE)		1	T AUGER
B RE	4. 0'	1.8'	45x					40		RUN +1				35.5 I INTER PERME	ABILITY TE
	4. 0'	₩R	NR							RUM #2				CORED VIREL INFRE BIT V	TO 80.5 FI LESING NXI INE DIAMON GNATED CON ITH FRESH
	1.5	0.5	30%				611.9	45.5	7	3					T CIRCULAT
	5.0'	3. 4'	67%					50 -		RUN 64	45.5 TO 70.4 FT LIMESTON 1SH GRAY(5YR 4/1) TO YEN (10YR 5/4). NOD. TO SEVI MED. HARD TO HARD. CLOSS FRACTURED WITH FRACTURES FROM HORIZONTAL. BOTH BE	LOWISH ORAN ERELY WEATHE ELY TO MOD. 5 10°TO 30°	GE RED	MURL IN 46.0 LOSS	UATING. STEN/KESKUK FT TOTAL OF LATION.
				17.9	10	5					COLORED STAINING ALONG S CHERT LAYERS AND LENSES		ES.		
	5.0'	4.5	<b>9</b> 02	19.8 17.9	20 10	5 7		55		RUN •5	51.0 TO 51.9 FT CHERT W 54.2 TO 54.3 CHERT WITH DISTINCTIVE CHERT INTER 54.0 TO 54.3 FT. 54.7 TO 54.9 FT.	ITH VUGS. VUGS.		EN.	AP LP (FT) (FT)
	5. 0'	5. 0'	100x					50		RUN •6	68.2 TO 70.5 FT.			5 6 7	0 0 0.1 0.2 0.2 0.6 0.3 1.0 0.3 0.4 0.3 0.5 0.1 0.3 0.2 0.5
	2 6	2 0	180~							-				"	
		2.0°		0.96	10	5		65 -							
	5.0	4.8	96x	0.42	10	5				6.					
							587.0	70.4							
	5.0	5.0'	1 <b>0</b> 0x				582.4	75		RUN +10	TO.4 TO BD.5 FT LIMESTO GRAY(NB). SLIGHTLY WEAT MODERATELY FRACTURED. W INTERBEDS OF BROWNISH G	HERED. HARD. 1TH LENSES A			
	25-4	TUT ST	TOOM STIS	ELBY TU	RL,	1	int		AC	ROS	S INTERSECTION FROM BLDG	412		MOLE NO	GA-5



TTER	DVANCE FFE FILM	RECOVERY RECOVERY	FLE BLOWS	,	MATER MESSLIR TESTS	E		=	201:	TE ST		MOTES ON! MATER LEVELS,
AND DIA	NEWLER !	SWOLE RE	SAMPLE BLOWS "H" PERCENT COPE RECOVERY	LOSS JN G.P.M.	PRESSURE P.S. 1	1)NE IN NIMUTES	ELEVATION	75	OLVENIC LOG	SAMPLE	BESCRIPTION AND CLASSIFICATION	MATER RETURN, CHARACTER OF DRILLING, ETC.
NXB CORE	5. 0'	4. B'	96							RUN +1.1	CHERT PRESSURE SOLUTION CREMULATIONS (STYLOLITES). VIJG @ 73.3 FT.	AP LP RCO RUN (FT) (FT) (Z) 11 0.4 1.1 TO
				-				80.5			BOTTOM OF BORING AT 80.5 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INC 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 67.5 TO 77.5 FT.	
											AP=AVERAGE LENGTH OF CORE PIECES FROM EACH RUN. LP=LONGEST PIECE OF CORE FROM EACH RUN. ROD=ROCK QUALITY DESIGNATION FOR EACH RUN.	ALL SOIL AND ROCCOLOR DESCRIPTION THE ROCK COLOCTOL THE GEOLOGICAL SOCIETY OF AMERICA, 1948.



MTE.	G	EOI	OGIC	DR	LL I	_0C		PROJEC		Ρ-	WELDON	SPRING	SITE	1450		_1	<b>#</b> 2	HOLE NO. G-10/GMW
		00	N ENTRA			OTECH	COORDINATES		DPLL MA		00,200	¥49,6	SD HOLE SEE	OVERBUREDI		FROM H 90 ROCK 6	)	TOTAL SEPTH
	/86 RECOV	Drie	7/5/86 -/10	COR			G. MATTHE!	<b>Y</b> S			5/CME-750 10 EL		6-1/4"/3"			<u> </u>	40.5	64.0
	;	31/14	l		4	4		•			57.8		52.376	_		BP IN	23.57	
			JOHT /FALL		CVE	<b>K. LIFT</b>	# MOLE DAJ 2 / 64.0		1		LOGGED ST	ři.	LAURE	NCE YOUNG/	E. BER	RGLUND		
METER	SOR RUE	RECOVERY	SAMPLE BLOWS  WENCENT CONE		MESSURE TESTS		ELEVATION	Ě	PLANE LOG	FIE.		Michell	OH AND CLAS					ES ON PRILITYELS,
90	לאושונע אמאי	300	2 E	ğ= 3	200 P		657.8	-		3				,				NACTER OF LINE, ETC.
-	·										YELLOWI GRAY (5' LIGHT G	SH <b>Bro</b> Yr4/1) Ray (N	WN (10YR! , MOTTLE! 6) SILT !	AY, MODER/ 5/4) TO BY D WITH NEL ENSES, MO	ROWNI DIUN		WITH E	FT DRILL V41N OD H EM AUGERS ENTER PLU
	18"	16*	16	4	6	10	·	5		-	WERT ST	lff, O	XIDIZED I	ZONES.				
SS 2*	18*	14*	16	3	7	9		10		2							WAS RAI	OFT BOREHOI
S	18"	221	18	6	7	11	642.3	15.5		3				CLAY, MOC				BY EBERLII ICAL CORP.
S	18"	18"	24	5	11	13				4	Brown (: Subround Stringer	ED FI	), MOIST, NE GRAVEL	VERY STI	STTE	SOME		
								20			•						fusal, Interf Neabil	T AUGER R ATTEMPTE ACE PERM- ITY TEST,
	1'	<b>0.3</b> 5	35x				634.3	23.5 25	1-		LIGHT OF WEATHERS	EAY (N D, NO	6), SLIGH DERATELY	ONE, MEDI ITLY TO ME FRACTURED	OERA'		AROUND AUGERS BURL IN	LEAKED   DUTSIDE       GTON/KEOK
XB	9'	5. 0'	<b>56</b> %	17.1 18.6 16.0		5 5 5		30			FILLED N INTERBED SOME ZONE EXTREMEL LINESTON TO .5 IN 28.5 TO 31.0 TO	VITH L DS, FII DES OF LY WEA' DE, FE! ICH IN 30.5 I 34.0 I	IGHT GRAY LLED VOIC DUSKY YE THERED TO W STYLOLI DIAMETER FT. CLAY	' SEAN. ENELY VEA	RD, CI 10ULE! 1/4), ED VUGS	HERT S, UP	CORED VIRELI IMPREG BIT VI VATER. 23.5 F BOREHO	T EEOLOGI
			00% ST#SH	D &		18	622.8	35			SOME CHE	RT NO	XLES.	INESTONE				TED TO RING WELL
	P00		MIDD	0-01HE			••				MAIN EN	TRANCE	GATE			ľ		0/GM-17



	G	EOL	.OGIC	DRII	LL	.0G	72	O.EC1	FUSF	WP	- WELDON SPRING SITE	H50F20I 2	er 2 G-10/GMH-17
SAMPLE TYPE BO GAMETER	NETH COPE RUN	OF RECOVERY	אבכמענוע כמה א א זיישונ שימה:	1055 H 74	BATER TESTS	ME. M. Es	ELEVATION	MT	901 JAMES   100	SAMPLE	DESCRIPTION AND CLASSIFICA	TEM	MATER BAN MATER RETAINS MATER RETAINS GROANCTER OF MELLING ETC.
	<b>3</b> 15	310	, IE	- a	F.	- 5	627.3	35	ļ.,	L			
NXB 3°	5'	5,0'	1002					40		FRUN +3	33.0 TO 38.0 FT FEW SMALL 1/4-INCH IN DIAMETER, FIL CALCITE. 38.0TD 44.0 FT FEW CAVITI 1-1/2 INCH DIAMETER FILLE 41.5 TO 42.3 FT THREE,2-1 OF EXTREMELY WEATHERED LT	LED WITH SOFT  ES UP TO  D WITH CHERT.  NCH THICK BEDS  NESTONE, WITH	man Gir Gir (X)
3°	6'	5.9'	98x				613.7	44. 1		AN OF	MEMEROUS CHERT FILLED VOI 42.3 TO 42.8 FT DECOMPOSE YELLOW(5Y 6/4) LINESTONE.	ED, DUSKY	2 9.15 8.45 75 3 8.25 8.6 18 4 8.2 8.45 41 5 8.25 8.8 38 6 9.25 2.5 76 7 9.25 1.3 80
ихВ 3'	8'	6.3'	75x					50		RUN 65	44.1 TO 61.5 FT LIMESTONE YELLOW(5Y 6/4), MODERATE MEDIUM HARD, MODERATELY I FRACTURED, NUMEROUS MEDII (N6), HARD CHERT FILLED Y BEDS, AND NODULES.  52.3 TO 54.9 FT 90x OF C	LY MEATHERED, HORIZONTALLY UM LIGHT GRAY VOIDS, INTER-	<b>∑</b> 6/25/86
3'	7'	6.6'	94%					55			BLUE(5PB 6/2) CHERT FILL	ED WOIDS AND	
2,	5'	4.9	98x				596.3 593.8	60 61.5	芸		G1.5 TO 64.0 FT LIMESTON GRAY(NG), WITH GRAYISH B CHERT MODULES UP TO 3 INC SLIGHTLY WEATHERED TO FR ZONTAL FRACTURING, 50X O BOTTOM OF BORING AT 64.0 HOLE TO 8-1/2 INCH AND I	LUE(5PB 5/2) HES IN DIAMETER, WESH, SOME HORI- WE CORE IS CHERT OF T. REAMED	
											316L STAINLESS STEEL MON SCREENED FROM 53.0 TO 63 AP-AVERAGE LENGTH OF COI EACH RUN. LP-LONGEST PIECE OF COR ROD- ROCK QUALITY DESIGNAM.	ITTORING WELL  3.0 FT.  RE PIECES FROM  E FROM EACH RUN	AMERICA, 1948.
-			PODA STA			1	SULT.	1_	1		MAIN ENTRANCE GATE		HBLE HD. G-10/(3441-17

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$\dashv$	****			╀	5 e	**	30 F	661.4	0	-0:	╁┤	D TO 1.	O FT G	RAVEL, L	IGHT GRAY	(N7),	-	0-32.5	FT DRILLE
至								660.4	1	1//	N	CRUSHED	LINES		MODERATE				IN OD HOL
ا م					.					<b>¥///</b>	1	1.0 TO	7.0 F1	SILTY C	LAY/CLAYE				LH MOCHO
SS 2"	18"	15*	13	†	3	5	8			<b>Y</b> //	1-5				Y(10YR 5/ N1), WEAT				
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e. HSA				l				634.4	27	<b>#</b>		27. D T	32.5	FT CRAV	LLY CLAY			BLFL 1	ngton/keok
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5. 22	18"	5.	41		8	18	23		34	32	15	DARK Y	LLOVI	SH BROWN	RAVEL. CH (10YR4.5/	2) IN	THE	CORED	WITH NOB
HSA									~	37	4				RK YELLOW , EXTREME		range		INE DIAMON GNATED CO
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	G	EOL	OGIC	DRI	LL	.0G	FI	NECT .	FUSF	WP	- WELDON SPRING SITE USO NO. SMEET (	NO. NOLE NO. OF 2 CA/W-18
TYPE ETG	ADVANCE DRE NUN	COVERT	SAMPLE BLOWS  WENGENT COME WENGENT		BATER TESTS		MOTAVELE	HLAZ	THAT LOS	SAMPLE	BESCRIPTION AND CLASSIFICATION	NOTES DIO BATER LEVELS, BATER RETUROL
SAMPLE TYPE AND DAMETER	LENCTH CORE REN	CANDLE MCONERY CANDLE MCONERY	The NA	1083 1083	UZ.9	# = 55 55 55 55 55 55 55 55 55 55 55 55 55	626.4	35	Ē	3		BURACTER OF BELLOIS, ETC.
NVB 3'	5'	3.5'	702				622.9	38.5		RUN •2	WITH VERY LIGHT GRAY(NB) CLAY AND ANGULAR CHERT FRAGMENTS, MANGANESE OXIDE DEPOSITS ON FRACTURE SURFACES. 35.0 TO 37.3 FT LIGHT GRAY(NT) CLAY, EXTREMELY MEATHERED LIMESTONE, AND ANGULAR CHERT FRAGMENT. 38.5 TO 57.5 FT LIMESTONE, YELLOWISH	7/8/86
NXB 3*	5'	0.8	16%	0.7	10	5				RUN •3	BROWN(10YR 5/4), EXTREMELY WEATHERED TO DECOMPOSED, MEDIUM HARD WITH CLAY SEAMS AND HORIZONTAL FRACTURES, CHERT	AP LP 800 BLN (FT) (FT) (X) 1 0.2 0.35 16 2 0.1 0.25 0 3 0.1 0.25 0
мхв 31	5'	1.4'	287	1.3	20	5 5		45 -		FIN 64		3 0.1 0.25 0 4 0.25 0.3 0 5 40.1 0.1 0 6 0.2 0.35 32 7 0.15 0.35 7 8 0.2 0.35 22
NXB 3'	2'	.5'	25x					50	呈	N.		
NXB 3"	3'	1.1	37%					55		RIN 66		
NXB 3'	5'	5.0	100%				603.9	57.5	#	NE -	YELLOWISH BROWN (10YR 5/4), EXTREMELY MEATHERED, MODERATELY HORIZONTALLY	
3. NXB	5'	5.0	1002								FRACTURED, WITH HARD, LIGHT GRAY(NT) CHERT FILLED WOIDS, SOME OF WHICH ARE INCOMPLETELY FILLED.	
							596.4	65			BOTTON OF BORING AT 65.0 FT. REAMED HOLE TO 8-1/2 INCH AND INSTALLED 2-INCH 316L STAINLESS STEEL MONITORING WELL SCREENED FROM 53.0 TO 63.0 FT.	SOIL AND ROCK COLOR DESCRIPTION FROM THE ROCK COLOR CHART,
									1		AP-AVERAGE LENGTH OF CORE PIECES FROM EACH RUN.  LP-LONGEST PIECE OF CORE FROM EACH RUN	PRINTED BY THE GEOLOGICAL SOCIETY OF
									-		ROD- ROCK QUALITY DESIGNATION FOR EACH RUN.	AMERICA, 1948.
-			POON STA				SULE	1_	_ـــــــــــــــــــــــــــــــــــــ	1	SOUTHEAST OF BLDG 434	NOTE NO.

APPENDIX B
TRENCH LOGS

# BECHTEL TRENCH LOG

EXCAVATION NO. 7-1

OJECT																						
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- 1 TOPSOIL/FILL BROWN, SANDY, CLAYEY SILT AND GRAVEL.
- SILT (LOESS) MOTTLED YELLOWBROWN AND GRAY, CLAYEY SILT/SILTY CLAY, SILT DECREASES WITH DEPTH, PLASTICITY INCREASES FROM LOW TO MODERATE WITH DEPTH. DAMP. SOME VERY WEATHERED IRON NODULES UP TO 1/4 .

  FEW SCATTERED SUBROUNDED, QUARTZ AND CHERT, FINE TO MEDIUM SAND GRAINS.
- CLAY, CHERT BEDS, AND VERY WEATHERED BLOCKS OF LINESTONE (BURLINGTON/KEOKUK FM. RESIDUUM) MOTTLED BRICK RED (DOMINANT COLOR), YELLOWBROWN, BROWN AND GRAY (5.0' 9.7') AND MOTTLED YELLOWBROWN AND GRAY (9.7' 15.0') SILTY CLAY. DAMP. LOW PLASTICITY. BLOCKY FRACTURE. LIGHT GRAY, WEATHERED WHITE ON SURFACE, MARD CHERT BEDS (~3D% OF EXPOSED UNIT), 1 TO 9 INCHES THICK (2 THICKEST BEDS SHOWN), FLAT LYING. ONLY A FEW BLOCKS OF ORIGINAL LIMESTONE REMAIN. THESE ARE WHITE, SOFT, INTENSELY WEATHERED AND SHOW NO STRUCTURE, (LARGEST BLOCK WAS ~12" X 9"). CONTACT BETWEEN UNITS 2 AND 3 IS MARKED BY AN ~2" THICK ZONE OF BLOCK CLAY WITH A VERY HEAVY CONCENTRATION OF MANGANESE DEPOSITION.

SIDE WEST	BEARING NI°E	EST END CONSTRUCTION CO, INC.	GEOLOGIST E. BERGLUND
WSST1.DGN			

# BECHTEL TRENCH LOG

EXCAVATION NO. T-2

WELDON SPRING PROJECT \_ BACKHOE 4-30-86 5-1-86 METHOD OF EXCAVATION \_\_ DATE EXCAVATED DATE BACKFILLED \_\_ (3) 3 3 Z 8 9 10 11 5 5 12 -13 SHORING (TYP.). 14 -**EXCAVATION** LIMITS -15 -7 8 14 15 16 17 18 19 20 9 10 13 11 12 HORIZONTAL DISTANCE IN FEET

#### MATERIAL DESCRIPTIONS:

- 1) TOPSOIL BROWN CLAYEY SILT WITH SOME GRAVEL.
- FILL GRAY SILTY SANDY GRAVEL.
- SILT (LOESS) MOTTLED GRAY AND YELLOW DRANGE, SLIGHTLY CLAYEY SILT. SLIGHTLY DAMP. FRIABLE. SOME MAN-GANESE STAINING. NUMEROUS WEATHERED RUST BROWN IRON NODULES.
- CLAY (FERRELVIEW FM.) MOTTLED GRAY AND YELLOW DRANGE (LESS MOTTLED BELOW 5.7') SILTY CLAY. DAMP. CON-COIDAL FRACTURE. MODERATELY PLASTIC. FEW SCATTERED, FINE- TO MEDIUM-GRAINED, SUBROUNDED SAND GRAINS (QUARTZ AND CHERT). FEW VERY WEATHERED RUST BROWN IRON NODULES.
- CLAY TILL MOTTLED GRAY AND YELLOW BROWN SILTY CLAY, DAMP, MODERATELY PLASTIC, WITH SCATTERED FINE- TO MEDIUM-GRAINED, SUBROUNDED QUARTZ AND CHERT, SAND GRAINS, SUBROUNDED TO SUBANGULAR FINE TO COARSE, CHERT AND LIMESTONE GRAVEL AND SUBROUNDED COBBLES UP TO 2"X3" (CHERT AND LIMESTONE), BLOCKY FRACTURE WITH MANY FRACTURE SURFACES COATED WITH MANGANESE. NUMEROUS VERY WEATHERED, RUST BROWN, IRON NODULES UP TO 1/8".

NOTE: 13.5-15.0' INTENSE MOTTLING 9.7-14.2' GRAVEL AND COBBLES 2-4%

14.2-15.0' GRAVEL AND COBBLE CONTENT INCREASES TO 20-25%

SIDE NORTH	BEARINGNBO°W	EXCAVATOR_	WEST END CONSTRUCTION CO., INC.	GEOLOGIST E. BERGLUND
WSST2. DON				

PROJECT WELDON SPRING			JO	B NO	14501-201	GROUND EL	665.8	_ LOCATION	N98,621	<b>W</b> 50,844		
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FILL - BROWN, CLAYEY SILT, DRY, SOME SCATTERED GRAVEL.

MATERIAL DESCRIPTIONS:

WSS13.DOV

- SILT (LOESS) MOTTLED GRAY AND YELLOW BROWN, SLIGHTLY CLAYEY (CLAY CONTENT INCREASES WITH DEPTH), SLIGHTLY DAMP, FRIABLE, MANGANESE STAINING, MANY VERY WEATHERED IRON NODULES.
- CLAY (FERRELVIEW FORMATION) MOTTLED MEDIUM GRAY WITH YELLOW BROWN, SLIGHTLY SILTY, DAMP, MODERATELY PLASTIC INCREASING WITH DEPTH, SCATTERED PIECES OF FINE TO MEDIUM SAND AND ANGULAR TO SUBROUNDED CHERT GRAVEL (1/2" 2"#). BREAKS CONCOIDALLY. FEW VERY WEATHERED IRON NODULES. MANGANESE STAINING ALONG SOME BREAKS.

		WEST END CONSTRUCTION	
SIDE EAST	BEARING N20°W	EXCAVATOR CO., INC.	GEOLOGIST E. BERGLUND

MATERIAL DESCRIPTIONS: HORIZONTAL DISTANCE IN FEET FILL - MIXED GRAY AND YELLOWBROWN SILTY CLAY/CLAYEY SILT WITH DEBRIS (ROCK, GRAVEL, BRICK, WIRE, ASPHALT, CONCRETE, RAILROAD TIE).

Hi

В

CLAY - MEDIUM GRAY MOTTLED WITH ORANGE BROWN, SILTY. MODERATELY PLASTIC, DAMP. FEW SCATTERED PIECES OF ANGULAR GRAVEL (3/8" - 3/4"#). FEW VERY WEATHERED IRON NODULES (RED BROWN).

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16

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-LIMITS OF EXCAVATION

18

SHORING

(TYP.)

19

(3) SILT - DARK GRAY, SLIGHTLY CLAYEY, SLIGHTLY DAMP - CRUMBLY.

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15 -

- CLAY NEDIUM TO DARK GRAY. SILTY. MDIST. MANY VERY WEATHERED DRANGE-YELLOW IRON NODULES (1/8" 1/4"#). LITTLE ANGULAR MEDIUM SIZED GRAVEL (DNE 4" X 6" CHERT COBBLE DBSERVED). MODERATELY PLASTIC. FEW PIECES OF SCATTERED FINE TO MEDIUM SAND.
- (5) SILT - MEDIUM GRAY, CLAYEY, SLIGHTLY DAMP, CRUMBLY, FEW SCATTERED PIECES OF FINE TO MEDIUM SAND.
- SAME AS 5 EXCEPT GRADES INTO CLAY WITH DEPTH. (THE 5 6 CONTACT IS WELL DEFINED WHEREAS THE 5A 6 (SA) CONTACT IS GRADATIONAL).
- **(6)** CLAY - MEDIUM GRAY MOTTLED WITH YELLOW-BROWN. SLIGHTLY SILTY (MODERATELY PLASTIC) NORTH END OF TRENCH GRADING SILTIER TO SOUTH END OF TRENCH (BECOMES LESS PLASTIC). DAMP. FEW PIECEOF FINE TO MEDIUM GRAINED, ANGULAR SAND. FEW SCATTERED PIECES OF ANGULAR CHERT, GRAVEL ( UP TO 3/4 0). MANY SMALL, VERY WEATHERED, IRON-RED TO YELLOWP-ORANGE IRON NODULES (1/16 - 1/4 0).
- SILT LIGHT BLUISH GRAY TO MEDIUM GRAY. SLIGHTLY CLAYEY. WET AT NORTH END OF TRENCH TO VERY MOIST AT SOUTH END. (SLIGHT SEEPAGE INTO TRENCH FROM THIS UNIT IN NORTHERN PART OF TRENCH). INTENSE RED-BROWN IRON STAINING ALONG A BLOCKY FRACTURE FEATURE. MANY VERY WEATHERED, IRON-RED TO YELLOW-BROWN IRON NODULES (1/16" - 1/2"8).

BEARING N24°E EXCAVATOR WEST END CONSTRUCTION CO., INC. GEOLOGIST E. BERGLUND

# BECHTEL TRENCH LOG

EXCAVATION NO. T-6

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- (1) TOPSDIL BROWN, CLAYEY SILT, SLIGHTLY SANDY, SOME FINE TO MEDIUM GRAVEL. DRY.
- FILL MOTTLED GRAY AND YELLOW-BROWN, SLIGHTLY SILTY TO SILTY CLAY, WITH SCATTERED FINE TO MEDIUM GRAVEL AND A FEW COBBLES, SLIGHTLY DAMP.
- 3 CLAY (FERRELY]EW FORMATION) MOTTLED GRAY AND YELLOW-BROWN, SILTY CLAY, FEW IRON NODULES AND RARE SAND GRAINS (QUARTZ AND CHERT). DAMP. MODERATELY PLASTIC.
- CLAY TILL MOTTLED YELLOW-BROWN AND GRAY, VERY SILTY CLAY, SAND CONTENT UP TO 5%, SAND SUBROUND, MEDIUM GRAINED CHERT AND OUARTZ. DAMP TO SLIGHTLY DAMP, VERY LOW PLASTICITY. BLOCKY FRACTURE WITH FRACTURE SURFACES COATED WITH MANGANESE. GRAVEL, COBBLES, AND BOULDERS MAKE UP 10 15%. GRAVEL IS SUBANGULAR TO SUBROUNDED, FINE TO COARSE GRAINED. COBBLES AND BOULDERS ARE SUBROUNDED AND UP TO 1 1/2 . GRAVEL IS CHERT AND LIMESTONE. COBBLES AND BOULDERS ARE VERY WEATHERED WHITE LIMESTONE AND GRAY CHERT WITH WHITE WEATHERED RIMS.

		WEST END CONSTRUCTION	
SIDESOUTH_	BEARING N34W	EXCAVATOR CO., INC.	GEOLOGIST E. BERGLUND

W5516.00

# APPENDIX C SEISMIC REFRACTION SURVEY REPORT

SEISMIC REFRACTION SURVEY WELDON SPRING CHEMICAL PLANT WELDON SPRING, MISSOURI

A Report Prepared for:

Bechtel National, Inc. P. O. Box 350 800 Oak Ridge Turnpike Oak Ridge, Tennessee 37830

bу

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> May 7, 1986 Job No. 86-144.01

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#### I SUMMARY

A seismic refraction survey was conducted at the Weldon Spring Chemical Plant, Weldon Spring, Missouri during the period February 27 through March 3, 1986. The purpose of the survey is to provide subsurface information that will aid in determining overburden thickness, the depth to and variability of the bedrock, and any anomalous conditions that are pertinent to the site characterization investigation.

The site is underlain by a sequence of unconsolidated materials overlying the Burlington/Keokuk cherty limestone formation. The overburden sequence is comprised of six stratigraphic units. The limestone is highly variable due to solutioning and other weathering and therefore has a highly irregular surface that has been referred to as pinnacled.

The results of the seismic refraction survey indicate that the subsurface can be defined by four seismic layers or units that are variable in thickness and velocity in the upper 100 to 125 feet. Generally Layers 1 and 2, with average velocities of about 1100 feet per second (fps) and 3000 fps, respectively, predominately represent the overburden but may also include weathered bedrock in the deeper sections of Layer 2. The top of Layer 3 is approximately 15 to 45 feet deep and has an average velocity of 6000 fps. Layer 3 generally represents weathered and solutioned bedrock but the shallower or upper portions of the unit could also include more compacted or saturated overburden. Layer 4 averages 12,000 fps along Profile A and 17,000 along Profile B. The depth to the top is 43 to 110 feet and represents the harder more competent and less weathered rock. The

interfaces representing the tops of Layers 3 and 4 are probably an average of the actual conditions which are believed to be highly irregular and erratic. Therefore correllations of the seismic data with borehole data describing overburden thicknesses and depth to hard rock may vary locally by 10 to 20 feet in the very irregular areas.

#### II INTRODUCTION

This report presents the results of a seismic refraction survey conducted by Detection Sciences, Inc. at the Weldon Spring Chemical Plant Site, Weldon Spring, Missouri. This survey was authorized under Bechtel National, Inc. Subcontract Agreement No. 14501-201-SC-176. The field work was performed during the period February 27 through March 3, 1986 by Kenneth Blom, Principal Geophysicist and Marty Clasen, Geophysical Technician, Detection Sciences, Inc. with logistical support and field assistance from Larry Young and Robert Oreweiler, Bechtel Representatives.

# A. Purpose

The purpose of this survey is to provide subsurface information in regards to seismic layers, velocities, and anomalous conditions that may pertain to overburden thickness, depth and variability of bedrock and, groundwater levels. This information will be used with subsequent studies for overall site characterization.

#### B. Scope of Work

The scope of work includes providing all the necessary personnel and seismic equipment to perform the survey, acquiring and reducing the data, and preparing the final report. The field work consisted of obtaining seismic refraction data along two (2) profiles of 2000 and 2400 lineal feet, respectively, as designated by Bechtel. This report includes descriptions of our methodology and procedures, results, and a discussion of our

interpretation of the seismic profiles as it pertains to the geologic information provided by Bechtel.

# C. Site Description

The site is on gently rolling terrain where surface elevations generally range between about 600 and 675 feet above sea level. Previous investigations by Bechtel National, Inc. and others have described the geologic conditions in some detail. The lithology includes six unconsolidated overburden units that overly the Burlington/Keokuk formation. Generally, the overburden is listed (from the ground surface) as consisting of topsoil, modified loess, clay (Ferrelview formation), clay till, basal till, and cherty clay. Not all of these units are believed to exist everywhere under the site, therefore the overburden lithology varies. The bedrock is described as a cherty limestone that is gradationally weathered and highly variable within the upper 40 feet or so and therefore has a highly irregular surface. Competent Burington/Keokuk formation, fine- to coarse-grained limestone that is locally fractured and solutioned with voids, underlies the gradationally weathered zone.

#### III METHODOLOGY

# A. Data Acquisition

Seismic refraction data was obtained from two profiles referred to as Profiles A and B on the Location Map, Plate 1. As initially planned, the profiles were to be comprised of 200 ft. long geophone spreads using a hammer and plate seismic source. This was based on the assumption that higher velocity material (bedrock) is less than 50 feet deep as generally defined by previous investigations in nearby areas. However, the preliminary in-field analysis of the seismic data following the first day of data acquisition, indicated that the higher velocity material was deeper than anticipated. This necessitated modifying the approach and using the field procedures described below.

Seismic refraction Profiles A and B are comprised of a total of 8 and 7 geophone spreads each, repectively. Each spread is a colinear array of 12 geophones distributed at 25 foot intervals. Shot points were located at both ends of each spread 10 feet from the first geophone, making the total length of each spread 295 feet.

Seismic energy was provided by small explosive charges buried in the ground at depths of 2 to 3 feet. The explosives consisted of approximately one-quarter pound charges of 55% seismic gel detonated by instantaneous electric blasting caps attached to a seismograph high voltage blaster. Mark Products, Inc. digital grade geophones and a Geometrics ES-1210F 12-channel signal enhancement engineering seismograph were used to record the seismic data.

# B. Data Analysis

The amount of time it takes for a seismic compressional wave to travel from a shot point to each geophone in a spread is given on the seismic records for each shot. We plotted these data versus the shot point-to-geophone distances in the form of time versus distance (T-D) graphs. By fitting straight line segments to the arrival times, we identified the various seismic layers and determined their apparent velocities. These parameters and the arrival times served as input to computer programs which use both the time-intercept and time-delay methods to invert the seismic refraction data. The output consists of tables listing the true velocity of each seismic layer and the depth to the top of each layer beneath every shot point and geophone. From these tables, seismic velocity cross-sections were then constructed.

In addition, a velocity analysis of the deepest layer in each spread was performed. The analysis consists of determining the interval velocity of the layer between geophones. This defines lateral variations in velocity and aides in correlation between spreads.

### C. Limitations

Several assumptions and limiting factors should be considered when interpreting and/or applying seismic refraction information. These assumptions and limitations are inherent to the technique and are common to most interpretation routines. They are as follows:

- 1) The seismic velocity increases with depth, that is, the velocity of each layer is greater than that of the layers overlying it. If this is not the case, then the low velocity layer will not be detected and the computed depth to all the layers underlying it will be erroneous.
- 2) Lithologic layers will not be individually resolved unless their velocity contrasts with that of adjacent layers. Conversely, variations in the elastic properties of a given lithologic unit may result in two or more seismic layers corresponding to a single lithologic layer.
- 3) Unless otherwise designated, seismic layers are assumed to have a constant velocity along the entire length of the respective geophone spread.
- 4) Steeply dipping velocity layers may cause inaccurate depth estimates.
- 5) The depths to each seismic layer may not be straight down if the interface is not as deep off to the side of the profile as it is directly beneath it. This can be especially true where seismic interfaces are extremely irregular.
- 6) The velocity of a seismic layer can vary with direction depending upon the orientation of bedding planes, joints, fractures, etc. relative to the seismic profile. This can result in a slight discrepancy in the computed velocity and depth of seismic layers between crossing profiles.

#### IV RESULTS

The results of our seismic refraction survey are presented in the form of seismic velocity cross-sections as shown on Plate 2. Each profile (cross-section) shows the position of the ground surface and the underlying seismic interfaces, the velocities of the seismic layers, and the locations of the shot points. Also shown are the results of the velocity analysis of the deepest layer. This is indicated along the lower portion of the profile as lateral extent and differences in velocity below the deepest velocity interface.

The seismic data resolves the subsurface into 4 layers for both Profiles A and B. The velocity, thickness or depth, and geologic interpretation of each layer are summarized below:

- <u>Layer 1</u> 950 to 1200 feet per second (fps); up to 15 feet thick; represents topsoil and possibly other loose overburden such as the modified loess unit.
- Layer 2 Velocity ranges between 1800 and 5000 fps with an average of about 3000 fps; anomalously high and low velocities are located along Profile B; thickness of this layer ranges between about 10 and 43 feet; believed to represent predominately overburden material but probably includes weathered bedrock along the deeper portions of this unit.
- Layer 3 Velocity is 4000 to 7650 fps and averages about 6000 fps; depth to the top of this layer ranges between about 15 and 45 feet; probably represents predominately weathered bedrock, however the upper portion may also include more compacted and/or saturated overburden material.
- Layer 4 8000 to 25,500 fps but averages about 12,000 fps along Profile A and about 17,000 along Profile B; depth to the top of this unit is 43 to 110 feet, averages about 55 to 60 feet along Profile A and about 70 to 75 feet along Profile B; represents harder more competent and less weathered bedrock.

Reference to the profiles (Plate 2) should be made for specific elevations of the various velocity layers and lateral variations along a particular profile. Several areas along Profiles A and B should be noted as possible anomalous zones due either to noticeable differences in velocities or change in depths of the various seismic interfaces.

Along Profile A there is a significant increase in the thickness of Layer 2 and decrease in the thickness of Layer 3 below Shot Point 7. Below Shot Point 8 and approximately 50 to 75 feet south of Borings G-2 and G-2A, the depth to Layer 4 increases and the velocity decreases to approximately 8000 fps. Local anomalous areas may be beneath Shot Points 5 and 6 where the depth to Layer 3 is minimal.

Along Profile B, the most noticeable anomalous areas are the depressions of the Layer 4 interface east of Shot Point 4 and beneath Shot Point 8. A more subtle anomaly is the increase in velocity of Layer 2 to 5000 fps beneath Shot Point 3.

#### **V** DISCUSSION

Our interpretation of the seismic profiles indicates that the subsurface conditions are irregular and in many places probably erratic. This interpretation is based on high quality data and therefore has been little influenced by random error and "data scatter" during the data reduction and interpretation process. During this process, however, many of the assumptions and limiting factors inherent in the seismic refraction technique, as noted in Section IIIC, Limitations, have been strongly considered in order to derive a geologically reasonable interpretation. The most important of these limitations that may be applicable to the site conditions are: 1) it is assumed that the seismic velocity increases with depth and that each seismic layer has a higher velocity than the material above it; 2) seismic layers are assumed to have a constant velocity along the entire length of a particular geophone spread; and 3) lithologic layers may not be individually resolved unless they have a velocity contrast with adjacent layers.

A comparison of borehole data (2 boreholes along each profile) with the seismic profiles indicates that the contact between the overburden material and the upper bedrock surface is probably not clear and distinct along the entire length of each profile. Since the velocity in the weathered and solutioned bedrock is probably similiar to that in the lower portion of the overburden, the seismic interface representing that boundary is probably only an approximation. This means that the depth to weathered bedrock (as defined geologically) may vary somewhat from what is indicated by the

seismic profiles. It is conceiveable that locally this variance could be as much as 10 or 20 feet.

The depth to harder, more competent and higher velocity rock, is also irregular and probably affected by lateral differences in the weathering and solutioning of the shallower rock. Areas along the profiles where the high velocity rock is relatively deep indicate zones where the weathering and solutioning have affected the bedrock to a greater depth. This seismic interface between the lower and higher velocity rock is also believed to represent a gradational zone rather than a distinct change. Therefore, the depth to this boundary at a specific locality may vary from what is depicted by the seismic profiles. However, the variance is probably less than the 10 or 20 feet mentioned above for the overburden/weathered bedrock interface. Further evidence of the variability in the competent rock is provided by the results of the velocity analysis which indicates variations ranging up to approximately 8000 fps.

The difference in the average velocity of the more competent rock between Profiles A and B may be related to the profile orientation, since the velocity of a seismic layer can vary with direction depending upon the orientation of bedding planes, joints, fractures, etc. This is consistent with the reported orientation of fracture sets which trend N30 to 72E and N30 to 65W. Typically, seismic velocities are slightly higher parallel to the structure and lower perpendicular to it.

VI ILLUSTRATIONS

FIGURE C-1 LOCATION MAP (PLATE 1)

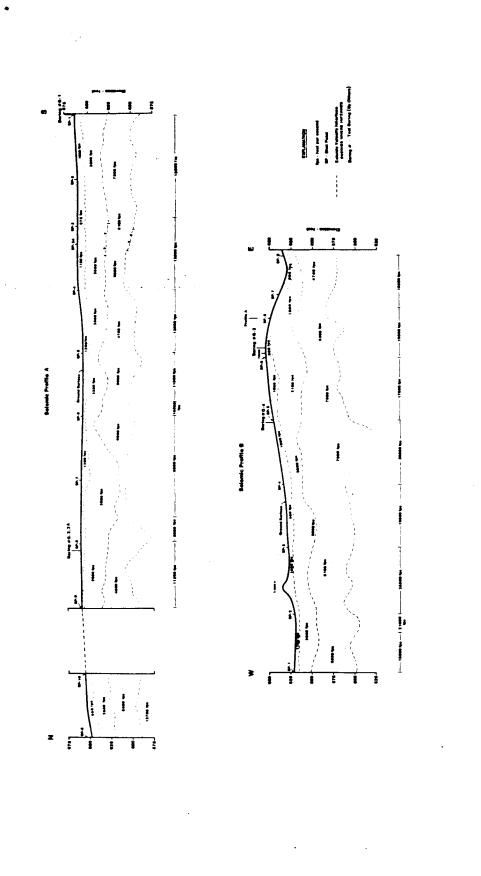


FIGURE C-2 SEISMIC PROFILES A AND B (PLATE 2)

# Appendix A

#### SEISMIC REFRACTION METHOD

The seismic refraction method consists of measuring the travel times of compressional waves through the subsurface. Seismic wave energy transmitted into the ground is refracted along velocity interfaces and back to the surface. By measuring the travel time of seismic waves from a source (shotpoint) to detectors at known distances along the ground surface, the seismic velocities and thicknesses of the respective seismic layers can be determined.

The effective depth of investigation can vary depending upon subsurface conditions. Typically, the depth of investigation for a given seismic profile is approximately one-third to one-fourth the maximum shot point to geophone distance, depending on the velocity contrast between the various seismic layers. Large contrasts in velocity can be detected at a greater depth than small velocity contrasts. Therefore, the depth of penetration can vary from one seismic profile to another.

Several energy sources can be used to generate seismic compressional waves. The two most common are small explosive charges detonated with electric blasting caps or a sledge hammer striking a steel plate. The latter is typically used for shallow investigations to depths of about 50 feet, whereas, explosives can be used for both shallow and deep surveys.

Shot points are typically located at both ends of a geophone line (spread) in order to detect and account for dipping seismic layers. Occasionally, interior shot points are located within a spread to more accurately define significant lateral velocity contrasts, to account for large topographic changes, or to increase the definition of shallow layers. Offset shot points located some distance away from the geophone spread can be used to attain a greater depth of penetration and to increase the definition of deeper layers. However, these do not provide data from the shallower layers along the particular spread.

Seismic refraction data is normally reduced by computer. Prior to computer data reduction, the seismic travel times to each of the geophones from the shot points are plotted on time versus distance graphs to determine the number of seismic layers and apparent velocities. This information along with ground surface elevations is then entered into two computer programs which compute the true velocities, the depths to, and/or thicknesses of the seismic layers. One program determines the depths and thicknesses under the shot points by a time-intercept method (Ewing and Press, Encyclopedia of Geophysics, 1961). The second program, referred to as the plus-minus method computes the layers under geophone locations for a particular spread (Hagedoorn, 1959, Geophysical Prospecting, v. 7, p. 158-182.).

The seismic velocity of earth materials is dependent on physical properties such as density, compaction, hardness, induration, and saturation. Other factors such as bedding fracturing, weathering and alteration, also affect velocity. Generally saturated and/or poorly to

semi-consolidated sediments will have a higher seismic velocity than unsaturated and/or unconsolidated material. In regards to bedrock, bedded and/or fractured or weathered rock will have a lower velocity than massive unfractured rock. Alteration of rock such as solutioning in limestone will tend to reduce the seismic velocity.

Because of the assumptions and limitations inherent to the seismic refraction method, seismic models should not be taken as an exact depiction of subsurface lithologic conditions. Since seismic velocities are typically measured over a large area and are dependant on the in-situ physical properties of subsurface materials, they may provide a better indication of certain characteristics than borehole data. However, it is best to consider seismic refraction models as an approximation of the subsurface geology. This is especially true in the absence of correlating subsurface data, or "ground truth." Seismic refraction data can best be utilized when it is correlated with borings or other subsurface information. This aids in eliminating some of the variables and reducing the assumptions that must be employed in its interpretation.

#### DISTRIBUTION

2 copies: Bechtel National, Inc. Jackson Plaza Tower

800 Oak Ridge Turnpike Oak Ridge, Tennessee 37831-0350

Attention: Mr. Mark Jones

# APPENDIX D SOIL TESTING DATA

Sample Number	:86-09-309-21A	Client I.D.:	G-5 SS-3
PARTICLE SIZE	ANALYSIS; ASTM Method I	0422	
	Particle Size 1mm ravity if High Soft, cohesive when we	or Low	
Sieve Ana			
Grain size	percentages and descriptions		Percentages
	rel-(Retained on No. 4 Sieve; cription:		0
<b>Coa</b> Desc	se sand-(Retained on No. 10 ription:	Sieve; 2.0mm)	0
Desc	um sand-(Retained on No. 40 ription: Mostly quartz, snents subrounded and limonit	ome limestone	14
Desc	Sand-(Retained on No. 200 Siription: Same as ngular	ieve; 0.075mm) above	17
Tota	Sand:		31
soaking 16 Silt-( Clay	r Analysis  Ispersed in apparatus A for hours in sodium hexametapho  .074mm to .005mm)  -(.005mm to .001mm)  ids-(Less than .001mm)	one minute after osphate solution.	27 8
	Silt/Clay/Colloids:		69
SPECIFIC GRAV	ITY: ASTM Method D854		
UNIT WEIGHT:	Volumetric Method	pcf-wet	
ATTERBERG TE	STS: ASTM Method D4318-8	4	
Liquid Lim Plastic Lin Plastic Ind	eit		·
PERCENT MOIS	TURE: ASTM Method D 2216		
CENTRIFUGE M	OISTURE EQV: ASTM Metho	od D 425-79	•••

Sample Number: 86 09 310 61A	Client I.D.:	G-5-ST-1
PARTICLE SIZE ANALYSIS; ASTM Metho		
Maximum Particle SizeSmm	or Low	
Sieve Analysis		
Grain size percentages and description	ons	Percentages
Gravel-(Retained on No. 4 Siemonded Description: Subrounded		_<1
Coarse sand-(Retained on No. Description: Subrounded		< 1
Medium sand-(Retained on No. Description: Subangular to su subrounded limestone.	40 Sieve; 0.425mm)	3
Fine Sand-(Retained on No. 200 Description: Same	O Sieve; 0.075mm)	17%
Total Sand:		20
Hydrometer Analysis  Soil was dispersed in apparatus A soaking 16 hours in sodium hexameta  Silt-(.074mm to .005mm)  Clay-(.005mm to .001mm)  Colloids-(Less than .001mm)  Total Silt/Clay/Colloids:	for one minute after phosphate solution.	31 3 41
		30
SPECIFIC GRAVITY: ASTM Method D354	2.43	
	129.5 pcf-wet 105.4 pcf-dry	
ATTERBERG TESTS: ASTM Method D431	3-34	
Liquid Limit 53 Plastic Limit 17 Plastic Index 36		
PERCENT MOISTURE: ASTM Method D 2	216-80 22.9%	
CENTRIFUGE MOISTURE EQV: ASTM Me	ethod D 425-79 34%	

Sample Number: 30-07-307-22A Client 1.D.:	G-6-1
PARTICLE SIZE ANALYSIS; ASTM Method D422	
Maximum Particle Size or Low Specific gravity if High or Low	
Sieve Analysis	
Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	
Total Sand:	•••
Hydrometer Analysis	
Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.	
Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	
SPECIFIC GRAVITY: ASTM Method D854 2.67 g/cm <sup>3</sup>	
UNIT WEIGHT: Volumetric Method pcf-wet pcf-dry	
ATTERBERG TESTS: ASTM Method D4318-84	
Liquid Limit Plastic Limit Plastic Index	
PERCENT MOISTURE: ASTM Method D 2216-80	
CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79	

Sample Number: _	36-09-310-02A	_ Client I.D.:	G-6-3
PARTICLE SIZE A	NALYSIS; ASTM Method I	D422	,
Maximum Pa Specific grav Hardness		or Low	
Sieve Analys	<u>is</u>		,
Grain size pe	rcentages and descriptions	3	Percentages
Descrip	(Retained on No. 4 Sieve; tion: Subrounded, le grains.		1
Descrip	sand-(Retained on No. 10 tion: Subrounded li		1
<b>Medium</b> Descrip	sand-(Retained on No. 40	tz, subrounded	5
. Descrip	nd-(Retained on No. 200 S tion: Subangular quar one and limonitic.		16
Total Sa	und & Gravel:		23
Hydrometer A	Inalysis		
Soil was disp soaking 16 ho	ersed in apparatus A for urs in sodium hexametaph	one minute after osphate solution.	
Clay-(.0 Colloids	4mm to .005mm) 05mm to .001mm) -(Less than .001mm) it/Clay/Colloids:		32 37 77
SPECIFIC GRAVITY	Y: ASTM Method D854	2.65 g/cm <sup>3</sup>	
UNIT WEIGHT: Vo	lumetric Method 136		
ATTERBERG TEST	S: ASTM Method D4318-8	4	
Liquid Limit Plastic Limit Plastic Index	46 17 29		
PERCENT MOISTU	RE: ASTM Method D 2216	6-8018.03	/s
CENTRIFUGE MOIS	STURE EQV: ASTM Metho	od D 425-7936%	

Sample Nu	ımber:	86-09-309-23A	Client I.D.:	G-8-1
PARTICLI	E SIZE ANA	LYSIS; ASTM Method	D422	
Spec	imum Partic lific gravity InessS		or Low 2.36	
Sieve	e Analysis			
Grai	n size perce	entages and description	<b>S</b> .	Percentages
	Gravel-(R Description	etained on No. 4 Sieve n: Limestone fra	; 4.75mm) gments angular	5
	Coarse sar Descriptio fragments		Sieve; 2.0mm) led, limestone	1
	Medium sa Descriptio fragments		O Sieve; 0.425mm) with limestone	2
	Fine Sand- Descriptio trash.	(Retained on No. 200 S n: Quartz-consid	Sieve; 0.075mm) erable organic	6
	Total Sand	<b>:</b>		14
Soil	ng 16 hours	lysis sed in apparatus A fo in sodium hexametaph im to .005mm)	r one minute after osphate solution.	47
	Clay-(.005) Colloids-(L	mm to .001mm) .ess than .001mm) Clay/Colloids:		12 27 86.
SPECIFIC	GRAVITY:	ASTM Method D854		
UNIT WEIC	HT: Volum	netric Method	pcf-wet	
ATTERBER	RG TESTS:	ASTM Method D4318-	8 4	
Plast	d Limit ic Limit ic Index			
PERCENT	MOISTURE	: ASTM Method D 221	6-30	
CENTRIFU	GE MOIST	JRE EQV: ASTM Meth	od D 425-79	•••

Sample Numb	er: <u>86 09 310 03A</u> Clie	ent I.D.:	G-8-3
PARTICLE S	IZE ANALYSIS; ASTM Method D422		
Specific 5	or Loss  Soft and cohesive when wet.	ow	-
Sieve A	nalysis		
Grain si	ze percentages and descriptions	1	Percentages
	ravel-(Retained on No. 4 Sieve; 4.75mn escription:		
	parse sand-(Retained on No. 10 Sieve; 2.		
De	edium sand-(Retained on No. 40 Sieve; Gescription:  Subangular quartz, subronestone and limonitic grains	punded	1
Fi	ne Sand-(Retained on No. 200 Sieve; 0.0 scription:  Same as above	75mm)	3
То	tal Sand:		4
Soil was	eter Analysis  dispersed in apparatus A for one miles  hours in sodium hexametaphosphate s	inute after solution.	
C1 Co	t-(.074mm to .005mm) ay-(.005mm to .001mm) elloids-(Less than .001mm) tal Silt/Clay/Colloids:		47 S 
SPECIFIC GR	AVITY: ASTM Method D8542.53 g/cr	n 3	
	: Volumetric Method	ocf-wet ocf-dry	
ATTERBERG	TESTS: ASTM Method D4318-84	•	
Liquid L Plastic I Plastic I	imit16		
PERCENT MC	ISTURE: ASTM Method D 2216-80	24.5%	
CENTRIFUGE	MOISTURE EQV: ASTM Method D 425	-79 41%	

Sample Number: 96-59-310-04A Chent I.D.:	G-8 6
PARTICLE SIZE ANALYSIS; ASTM Method D422	
Maximum Particle Size or Low or Low Hardness Soft and cohesive when wet.	
Sieve Analysis	
Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	
Coarse sand-(Retained on No. 10 Sieve; 2.0mm)  Description: Subangular limestone and quartz, subrounded limonitic grains.	
Medium sand-(Retained on No. 40 Sieve; 0.425mm)  Description:  Subangular quartz, and subrounded  limonite and limestone grains.	4
Fine Sand-(Retained on No. 200 Sieve; 0.075mm)  Description:  Same as above	17
Total Sand:	22
Hydrometer Analysis	
Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.	
Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	32 12 36 73
SPECIFIC GRAVITY: ASTM Method D854 2.61 g/cm <sup>3</sup>	
UNIT WEIGHT: Volumetric Method 121.1 pcf-wet 103.9 pcf-dry	
ATTERBERG TESTS: ASTM Method D4318-84	
Liquid Limit 47 Plastic Limit 16 Plastic Index 3!	
PERCENT MOISTURE: ASTM Method D 2216-80 16,9	<del></del> -
CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 33%	

Sample Nur	mber: <u>86 09 310 10A</u> Client I.D.:	C-9-2
PARTICLE	SIZE ANALYSIS; ASTM Method D422	
Speci	mum Particle Size	
Sieve	Analysis	,
Grain	size percentages and descriptions	Percentages
	Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	
	Coarse sand-(Retained on No. 10 Sieve; 2.0mm)  Description:  One angular chert fragment.	<1
	Medium sand-(Retained on No. 40 Sieve; 0.425mm)  Description: Mostly subangular chert and quartz.  subrounded limonitic grains.	1
1	Fine Sand-(Retained on No. 200 Sieve; 0.075mm)  Description:  Same as above	2
•	Total Sand:	3
Hydro	meter Analysis	
	was dispersed in apparatus A for one minute aftering 16 hours in sodium hexametaphosphate solution.	
	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	56 8 33 97
SPECIFIC G	GRAVITY: ASTM Method DS54	
UNIT WEIGI	HT: Volumetric Method 124.0 pcf-wet 103.5 pcf-dry	
ATTERBER	G TESTS: ASTM Method D4313-34	
Plastic	d Limit	
PERCENT A	MOISTURE: ASTM Method D 2216-80 24	.6%
CENTRIFUC	GE MOISTURE EQV: ASTM Method D 425-7935	0 <sub>0</sub>

Sample Number:	96-09-310-11A	Client I.D.:	G-9-5
PARTICLE SIZE AN	ALYSIS; ASTM Method D4	22	
Specific gravit	icle Size 3.5mm y if High Soft & cohesive when wet	or Low	
Sieve Analysis			
Grain size perc	entages and descriptions		Percentages
<b>Gravel-(</b> ) Descripti	Retained on No. 4 Sieve; bon:		0
Descripti	und-(Retained on No. 10 Sion:  Basalt chips, some ded quartz and limonitic groups)	ubangular	<1
Description	and-(Retained on No. 40 Son: Ouartz limonit	ieve; 0.425mm) ic grains,	4
Fine Sand Description	-(Retained on No. 200 Sievon:Same as a		17
Total Sand	d:		21
Hydrometer An	alysis		
Soil was disper soaking 16 hour	sed in apparatus A for c s in sodium hexametaphos	one minute after ohate solution.	
Clay-(.00) Colloids-(	nm to .005mm)  mm to .001mm)  Less than .001mm)  Clay/Colloids:		30 10 39 79
	ASTM Method D854	50 e/cm <sup>3</sup>	
UNIT WEIGHT: Volum		pcf-wet	
ATTERBERG TESTS:	ASTM Method D4318-84		
Liquid Limit Plastic Limit Plastic Index	50 16 34		
PERCENT MOISTURE	: ASTM Method D 2216-8	18.79	%
CENTRIFUGE MOIST	URE EQV: ASTM Method	D 425-79 45%	ó

Sample Num	nber: 86-09-309-17A Client I.D.:	G-10- 5S-2
PARTICLE S	SIZE ANALYSIS; ASTM Method D422	
Specifi	ic gravity if High or Lowess	
Sieve /	Analysis	
Grain:	size percentages and descriptions	Percentages
	Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	
	Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	
N D	Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	
<b>F</b>	Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	
т	Total Sand:	
Hydron	neter Analysis	
Soil wa soaking	as dispersed in apparatus A for one minute after g 16 hours in sodium hexametaphosphate solution.	
C	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	
SPECIFIC GI	RAVITY: ASTM Method D854	
UNIT WEIGH	HT: Volumetric Method 126.5 pcf-wet 107.9 pcf-dry	
ATTERBERO	G TESTS: ASTM Method D4313-84	
Plastic	Limit : Limit : Index	
PERCENT M	NOISTURE: ASTM Method D 2216-80	
CENTRIFUG	GE MOISTURE EQV: ASTM Method D 425-79	

Sample Nur	mber: 86-09-309-18A Client I.D.:	G-10- SS-4
PARTICLE	SIZE ANALYSIS; ASTM Method D422	
Speci	mum Particle Size ific gravity if High or Low ness	
Sieve	Analysis	
Grain	n size percentages and descriptions	Percentages
	Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	
	Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	
	Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	
	Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	
	Total Sand:	
Hydro	ometer Analysis	
Soil w soakin	was dispersed in apparatus A for one minute after ng 16 hours in sodium hexametaphosphate solution.	· ·
•	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	
SPECIFIC C	GRAVITY: ASTM Method D8542.62 g/cm <sup>3</sup>	<del> </del>
UNIT WEIGH	HT: Volumetric Method pcf-wet pcf-dry	
ATTERBER	CG TESTS: ASTM Method D4318-84	
Plasti	d Limit c Limit c Index	
PERCENT N	MOISTURE: ASTM Method D 2216-80	
CENTRIFU	GE MOISTURE EQV: ASTM Method D 425-79	

Sample Ni	ımber: <u>86-09-309-24A</u>	_ Client I.D.:	G-14-1
PARTICL	E SIZE ANALYSIS; ASTM Method D	422	
Max Spec Hard	imum Particle Size tific gravity if High dness	or Low	· 
Siev	e Analysis		
Grai	n size percentages and descriptions		Percentages
	Gravel-(Retained on No. 4 Sieve; Description:		
	Coarse sand-(Retained on No. 10 S Description:		
٠.	Medium sand-(Retained on No. 40 Description:		
	Fine Sand-(Retained on No. 200 Si Description:		
	Total Sand:	·	
Soil	ometer Analysis was dispersed in apparatus A for ing 16 hours in sodium hexametapho		
	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:		
PECIFIC	GRAVITY: ASTM Method D854	2.45 g/cm <sup>3</sup>	
JNIT WEIG	GHT: Volumetric Method	pcf-wet	
TTERBE	RG TESTS: ASTM Method D4318-8	4	
Plas	id Limit tic Limit tic Index	·	
ERCENT	MOISTURE: ASTM Method D 2216	5-80	-
ENTRIF	JGE MOISTURE EQV: ASTM Metho	od D 425-79	•-•

Sample Nun	n <b>ber:</b>		<u> 36-09-</u>	<u> 309-25</u>	A	_ CI	ent I.D	).:		G-15-7	
PARTICLE	SIZE	ANALY	rsis; A	STM M	lethod [	0422					
Specif	fic gra	avity if	Size _ High _ oft, coh	-		_	ow	2.4	4	_	
Sieve	Analy	/sis									
Grain	size p	percent	ages an	d desc	riptions	•				Percentag	<u>es</u>
		:I-(Ret ription:			4 Sieve;					0	
					No. 10					0	
					No. 40 Jartz, su					4	<del></del> -
		Sand-(R iption:			o. 200 S ne as me			)		4	<del></del>
•	Total :	Sand:		,						8	
Hydro	meter	Analy	sis_								
					s A for metaph						
(	Clay-( Colloi	(.005mr ids=(L <b>e</b> s	to .005 m to .00 ss than ay/Coll	(mm10 m100.						56 2 34 92.	
SPECIFIC C	RAVI	TY: AS	STM Ме	thod E	354						
UNIT WEIG	HT: V	Volume	tric Me	thod _		6.5 4.8	pcf-we pcf-dry				
ATTERBER	G TES	STS: A	STM M	ethod l	D4318-8	34					
Liquid Plasti Plasti	c Limi	it									
PERCENT N	MOIST	URE:	ASTM	Method	d D 221	6-80					
CENTRIFU	GE MC	OISTUR	RE EQV	: .AST	M Meth	od D 42	5-79				

Sample Numb	er: <u>86-09-309-26A</u>	Client I.D.:	G-16-1
PARTICLE SI	ZE ANALYSIS; ASTM Method D	422	
	m Particle Size gravity if High s	or Low	<del></del>
Sieve A	nalysis		
Grain si	ze percentages and descriptions		Percentages
	avel-(Retained on No. 4 Sieve; escription:		
Co	earse sand-(Retained on No. 10 Secription:		
Me De	edium sand-(Retained on No. 40 scription:	Sieve; 0.425mm)	
Fir De	ne Sand-(Retained on No. 200 Siescription:	eve; 0.075mm)	
То	tal Sand:		
Hydrome	ter Analysis		
Soil was soaking	dispersed in apparatus A for 16 hours in sodium hexametapho	one minute after sphate solution.	
Cla Co	t-(.074mm to .005mm) ay-(.005mm to .001mm) lloids-(Less than .001mm) tal Silt/Clay/Colloids:		
SPECIFIC GR	AVITY: ASTM Method D854 2	.62 g/cm <sup>3</sup>	
UNIT WEIGHT	: Volumetric Method	pcf-wet pcf-dry	
ATTERBERG	TESTS: ASTM Method D4318-84		
Liquid L Plastic L Plastic I	imit imit ndex		
PERCENT MO	ISTURE: ASTM Method D 2216	-80	
CENTRIFUGE	MOISTURE EQV: ASTM Metho	d D 425-79	

Sample Num	nber: <u>86-09-309-27A</u> Client I.D.:	G-18-1
PARTICLE :	SIZE ANALYSIS; ASTM Method D422	
<b>Spe</b> cif	num Particle Size 0.5mm fic gravity if High or Low ness Soft, cohesive when wet.	
Sieve	Analysis	
Grain	size percentages and descriptions	Percentages
	Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	0
( [	Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	0
	Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Quartz, limonitic rock modular- rounded-subrounded	1
	Fine Sand-(Retained on No. 200 Sieve; 0.075mm)  Description: Same as above	5
Т	Total Sand:	6
Hydron	meter Analysis	
Soil was soaking	as dispersed in apparatus A for one minute after g 16 hours in sodium hexametaphosphate solution.	
	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	65 8 21 94
SPECIFIC GI	RAVITY: ASTM Method D854	
UNIT WEIGH	HT: Volumetric Method pcf-wet pcf-dry	
ATTERBERG	G TESTS: ASTM Method D4318-84	•
Plastic	Limit Limit Index	
PERCENT M	MOISTURE: ASTM Method D 2216-80	
CENTRIFUG	GE MOISTURE EQV: ASTM Method D 425-79	

Sample Number:	36-09-310-124	_ Client I.D.:	G-19-2
PARTICLE SIZE AN	ALYSIS; ASTM Method I	0422	
Maximum Par Specific gravi Hardness		or Low	·
Sieve Analysis			
Grain size per	centages and description	S	Percentages
Gravel- ( Descript	Retained on No. 4 Sieve; ion: Angular ch		<1
Coarse s Descriptsubroun			1
Medium : Descript	sand-(Retained on No. 40 ion: Ouartz and che		5
Descripti	L-(Retained on No. 200 Son: Ouartz-subangul	ar, subrounded,	21
Total Sar	od:		27
soaking 16 hou Silt-(.074	rsed in apparatus A fors in sodium hexametaph	r one minute after osphate solution.	29
Colloids-	5mm to .001mm) (Less than .001mm) :/Clay/Colloids:		6 38 73
SPECIFIC GRAVITY	: ASTM Method D854	2.68 g/cm <sup>3</sup>	
UNIT WEIGHT: Volu	imetric Nethod 123	5.9 pcf-wet 7.9 pcf-dry	
ATTERBERG TESTS	: ASTM Method D4318-	34	
Liquid Limit _ Plastic Limit _ Plastic Index _	14		
PERCENT MOISTUR	E: ASTM Method D 221	6-3016.9;	<u>%</u>
CENTRIFUGE MOIS	TURE EQV: ASTM Meth	od D 425-79	%

Sample Number:	86-09-310-13A	_ Client I.D.:	G-20-2
PARTICLE SIZE	ANALYSIS; ASTM Method	D422	-
Specific gr	Particle Size 3.0mm avity if High Soft and cohesive when we see the second state of the second	or Low	
Sieve Anal	<u>rsis</u>		
Grain size	percentages and description	<b>S</b>	Percentages
Grave Descr	el-(Retained on No. 4 Sieve	4.75mm)	0
Descr	e sand-(Retained on No. 10 iption: Chert and quare limestone grains.	Sieve; 2.0mm) tz-subangular	<1
Descr	im sand-(Retained on No. 40 iption: Mostly quart: punded, some chert and limit	z-subangular	3
Descr	iand-(Retained on No. 200 Siption: Ouartz-suba	ngular with	11
Total	Sand:		14
Hydrometer	Analysis		
Soil was di soaking 16 h	spersed in apparatus A for ours in sodium hexametaph	r one minute after osphate solution.	
Clay-( Colloi	074mm to .005mm) .005mm to .001mm) ds-(Less than .001mm) Silt/Clay/Colloids:		36 5 45 86
SPECIFIC GRAVI	TY: ASTM Method D854	2.67 g/cm <sup>3</sup>	
UNIT WEIGHT: V	olumetric Method 121 96.		
ATTERBERG TES	TS: ASTM Method D4313-8		
Liquid Limi Plastic Limi Plastic Inde	t 19		
PERCENT MOIST	URE: ASTM Method D 2216	5-8023.5%	
CENTRIFUGE MO	DISTURE EQV: ASTM Metho	od D 425-79 46%	

Sample Number: 86.09.309.28A Client I.D.:	G-21 SS-1
PARTICLE SIZE ANALYSIS; ASTM Method D422	
Maximum Particle Size Specific gravity if High or Low Hardness	
Sieve Analysis	
Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	
Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	
Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	
Total Sand:	
Hydrometer Analysis	
Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.	
Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	
SPECIFIC GRAVITY: ASTM Method D854	
UNIT WEIGHT: Volumetric Method pcf-wet pcf-dry	
ATTERBERG TESTS: ASTM Method D4318-84	
Liquid Limit Plastic Limit Plastic Index	,
PERCENT MOISTURE: ASTM Method D 2216-80	
CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79	

• 

Sample Nu	Imber: 86-09-309-29A Client I.D.:	G-21 SS-2
PARTICLE	E SIZE ANALYSIS; ASTM Method D422	
	imum Particle Size	•
Hard	rific gravity if High or Low dness	
Sieve	e Analysis	,
Grai	n size percentages and descriptions	Percentages
	Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	
	Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	
	Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	
	Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	
	Total Sand:	
Hydro	ometer Analysis	
Soil soaki	was dispersed in apparatus A for one minute aftering 16 hours in sodium hexametaphosphate solution.	
	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	
SPECIFIC (	GRAVITY: ASTM Method D854	
UNIT WEIG	GHT: Volumetric Method pcf-wet pcf-dry	
ATTERBER	RG TESTS: ASTM Method D4313-84	
Plast.	d Limit 63 ic Limit 20 ic Index 43	
PERCENT	MOISTURE: ASTM Method D 2216-89	
CENTRIFU	JGE MOISTURE EQV: ASTM Method D 425-79	•••

Sample Nu	mber:86 09 309 30A Client I.D.: _	C-21/55-5
PARTICLE	SIZE ANALYSIS; ASTM Method D422	
<b>Spe</b> ci	fic gravity if High or Low nessSoft and cohesive when wet	<del></del>
Sieve	Analysis	
Grain	size percentages and descriptions	Percentages
	Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	0
	Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	0
·	Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description: Subrounded limonitic and limestone grains, subangular quartz.	
	Fine Sand-(Retained on No. 200 Sieve; 0.075mm)  Description:  Same as above	5%
	Total Sand:	<u>6%</u>
Hydro	ometer Analysis	
	was dispersed in apparatus A for one minute afteng 16 hours in sodium hexametaphosphate solution.	r
	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	63 11 20 94
SPECIFIC (	GRAVITY: ASTM Method D854	
UNIT WEIG	HT: Volumetric Method 114.1 pcf-wet 99.4 pcf-dry	
ATTERBER	RG TESTS: ASTM Method D4318-84	
Plast	d Limit 35 ic Limit 16 ic Index 19	
PERCENT	MOISTURE: ASTM Method D 2216-80	
CENTRIFU	GE MOISTURE EQV: ASTM Method D 425-79	

Sample Number:	86 09 310 09A	Client I.D.:	G-21 ST-1
PARTICLE SIZE	ANALYSIS; ASTM Method D	1422	
Specific gr	Particle Size	or Low	
Sieve Anal	<u>ysis</u>		
Grain size	percentages and descriptions		Percentages
	el-(Retained on No. 4 Sieve; ription:		
Desc	se sand-(Retained on No. 10 stription:  Subangular che ely scattered limonite	rt and quartz	1
	um sand-(Retained on No. 40 ription: Mostly subang		5
Descr	Sand-(Retained on No. 200 Siription:Subangula	r quartz	21
Total	Sand:		27
soaking 16	ispersed in apparatus A for hours in sodium hexametapho	one minute after sphate solution.	
Clay- Collo	.074mm to .005mm) (.005mm to .001mm) ids-(Less than .001mm) Silt/Clay/Colloids:	•	31 7 35 73
SPECIFIC GRAV	ITY: ASTM Method D854	2.64 g/cm <sup>3</sup>	
UNIT WEIGHT:	Volumetric Method	pcf-wet pcf-dry	
ATTERBERG TE	STS: ASTM Method D4318-8	4	
Liquid Limi Plastic Lim Plastic Inde	it13		
PERCENT MOIST	TURE: ASTM Method D 2216	5-8014.2	°5
CENTRIFUGE M	OISTURE EQV: ASTM Metho	od D 425-79	

# SOILS ANALYSIS CHEMICAL TEST

Sample Number:	8609310-09A	Client I.D.:	G-21 ST-1
CATION EXCHANGE	E CAPACITY; Hoddinott Met	thod	
Exchange Acid	ity, meq/190g o.d. soil =	29.84	-
Exchange Cation	on Content, meq/100g o.d. so	il (Ca) =	22.40
		(Mg)=	7.13
	•	(K) =	0.49
		(Na) =	0.98
	tive cation exchange capacit	y, meq/100g c	o.d. soil.
DISTRIBUTION RAT	IOS; Method D-4320-84 - See	: separate rep	ort.

# SOILS ANALYSIS CHEMICAL TEST

Sample Number: 8609310-09A Pro Dup	Client I.D.: _	C-21 ST-1
CATION EXCHANGE CAPACITY; Hoddinott M	ethod	·
Exchange Acidity, meq/100g o.d. soil =	28.61	
Exchange Cation Content, meq/190g o.d.	(Mg) = (Mg) = (K) = (Na) =	
ECEC = effective cation exchange capac ECEC = 59.9	ity, meq/100g o	.d. soil.

DISTRIBUTION RATIOS; Method D-4320-84 - See separate report.

Sample Nu	Imber: <u>86-09-309-01A</u> Client I.D.:	GMW-1 SS-1
PARTICLE	E SIZE ANALYSIS; ASTM Method D422	
Spec	imum Particle Size or Low ific gravity if High or Low	<del>-</del>
Sieve	e Analysis	
Graii	n size percentages and descriptions	Percentages
	Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	
	Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:	
	Medium sand-(Retained on No. 40 Sieve; 0.425mm) Description:	
	Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description:	
	Total Sand:	
Hydro	ometer Analysis	
Soil soakii	was dispersed in apparatus A for one minute after ng 16 hours in sodium hexametaphosphate solution.	
	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	
SPECIFIC (	GRAVITY: ASTM Method D854	
UNIT WEIG	GHT: Volumetric Method pcf-wet pcf-dry	
ATTERBER	RG TESTS: ASTM Method D4318-84	
Plasti	d Limit 30 ic Limit 17 ic Index 13	
PERCENT	MOISTURE: ASTM Method D 2216-80	-
CENTRIFU	IGE MOISTURE EQV: ASTM Method D 425-79	

Sample Number:	36-09-309-42A	Client I.D.:	GMW-1-ST-1
PARTICLE SIZE	ANALYSIS; ASTM Method D42	2	
Specific gra	article Size 24mm vity if High When dry, very friable	or Low	
Sieve Analy	<u>sis</u>		
Grain size p	ercentages and descriptions		Percentages
Descr.	I-(Retained on No. 4 Sieve; 4. iption: 3/4" - 21%, No. No. lar chert nodules.	. 4 - 18%	39
Coars	e sand-(Retained on No. 10 Sie iption:Angular chert	ve; 2.0mm)	11
	m sand-(Retained on No. 40 Sie ption: Angular chert	•	10
Descri	and-(Retained on No. 200 Sieve ption: Angular chert, with transported limonitic grains.	ace amounts of	5
Total :	Sand & Gravel:		65
Hydrometer	Analysis		
	spersed in apparatus A for or or ours in sodium hexametaphosp		
Clay-( Colloi	074mm to .005mm) .005mm to .001mm) ds-(Less than .001mm) Silt/Clay/Colloids:		10 2 23 35
SPECIFIC GRAVI	TY: ASTM Method D854	5 g/cm <sup>3</sup>	
UNIT WEIGHT: V	olumetric Method 107.9 36.5	pcf-wet pcf-dry	
ATTERBERG TES	iTS: ASTM Method D4318-84	v	
Liquid Limi Plastic Limi Plastic Inde	it		
PERCENT MOIST	URE: ASTM Method D 2216-8	023.0	)%
CENTRIFUGE MO	DISTURE EQV: ASTM Method	D 425-79 409	%o

Sample Nur	mber: 86-09-310-05A Client I.D.	:GMW-2 ST-1
PARTICLE	SIZE ANALYSIS; ASTM Method D422	
Speci:	fic gravity if High or Low nessSoft & cohesive when wet	
Sieve	Analysis	
Grain	size percentages and descriptions	Percentages
	Gravel-(Retained on No. 4 Sieve; 4.75mm)  Description:1" 7% 1 3/4-5%/ No. 4-13%  chert nodules and fragments.	
	Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description: Chert grains. Agular and irregula shape.	32%
1	Medium sand-(Retained on No. 40 Sieve; 0.425mn Description: Mostly limonitic grains-subrounde and slaglike blebs with minor quartz.	n) <u>6%</u>
1	Fine Sand-(Retained on No. 200 Sieve; 0.075mm) Description: Mostly limonitic grains with mino amounts of limestone and quartz.	<u> </u>
1	Total Sand & Gravel:	<u>66%</u>
Hydro	meter Analysis	
Soil w soakin	vas dispersed in apparatus A for one minute a g 16 hours in sodium hexametaphosphate solution	fter •
(	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	16 3 15 34
SPECIFIC G	RAVITY: ASTM Method D854	
UNIT WEIGH	HT: Volumetric Method pcf-wet pcf-dry	
ATTERBER	G TESTS: ASTM Method D4318-84	·
Plastic	Limit35 c Limit19 c Index16	·
PERCENT N	MOISTURE: ASTM Method D 2216-80	23.1%
CENTRIFUC	GE MOISTURE EQV: ASTM Method D 425-79	

# SOILS ANALYSIS CHEMICAL TEST

Sample Number: _	8609310-05A	Client I.D.:	GMW-2 ST-1
CATION EXCHAN	IGE CAPACITY; Hoddinott M	ethod	
Exchange Ac	cidity, meq/100g o.d. soil = _	9.02	
Exchange Ca	tion Content, meq/100g o.d.	(Ca) = (Mg) = (K) = (Na) =	13.58 5.49 0.46 0.45
ECEC = effe	ective cation exchange capac	ity, meq/100g o	.d. soil.

Sample Nur	nber:	\$6-09-309-02A	_ Client I.D.:	GMW'-3 SS-1
PARTICLE	SIZE ANA	LYSIS; ASTM Method [	0422	
Speci	lic gravity	ile Size  if High  oft & cohesive when w	or Low	
Sieve	Analysis	-		
Grain	size perce	ntages and descriptions	,	Percentages
	Gravel-(ReDescription	etained on No. 4 Sieve;		· · · · · · · · · · · · · · · · · · ·
		d-(Retained on No. 10 s		
	<b>Medium sa</b> Description	nd-(Retained on No. 40 Claystone an subrounded grains	Sieve; 0.425mm)	2
1	Description	Retained on No. 200 Si  Mostly quartz	, subrounded	3
•	Total Sand:			5
Hydro	meter Anal	ysis		
Soil w	as dispers	ed in apparatus A for in sodium hexametapho	one minute after sphate solution.	
(	Clay-(.005n Colloids-(Le	m to .005mm) nm to .001mm) ess than .001mm) Clay/Colloids:		65 7 23
SPECIFIC G	RAVITY: A	ASTM Method D854		
UNIT WEIGH	∄T: Volum	etric Method110	A	
ATTERBER	G TESTS:	ASTM Method D4318-8	4	
Liquid Plastic Plastic	Limit Limit Index			
PERCENT M	OISTURE:	ASTM Method D 2216	-80	
		RE EQV: ASTM Metho		
		-	<del></del>	

Sample Nu	mber: 86 09 309 03A	Client I.D.:	CMW 3 SS 2
PARTICLE	SIZE ANALYSIS; ASTM Method D42	2	
Speci	mum Particle Size3.3mmific gravity if Highnesssoft & cohesive when wet	or Low	
Sieve	Analysis		
Grain	size percentages and descriptions		Percentages
	Gravel-(Retained on No. 4 Sieve; 4. Description:	•	<del> , - , - , - , - , - , - , - , - ,</del>
	Coarse sand-(Retained on No. 10 Sieve Description:  Limestone fragangular to subrounded.	ments	3
	Medium sand-(Retained on No. 40 Sie Description: quartz, subro		3
	Fine Sand-(Retained on No. 200 Sieve Description:clear quartz, sub	e; 0.075mm) prounded	10
	Total Sand:		16
Soil v	was dispersed in apparatus A for oring 16 hours in sodium hexametaphosples Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm)	ne minute after hate solution.	26 10 48
	Total Silt/Clay/Colloids:		84
SPECIFIC (	GRAVITY: ASTM Method D8542.56	g/cm <sup>3</sup>	
UNIT WEIG	HT: Volumetric Method	pcf-wet	
ATTERBER	RG TESTS: ASTM Method D4318-84		
Liquid Plasti Plasti	d Limit c Limit c Index		
PERCENT	MOISTURE: ASTM Method D 2216-80	0	·
CENTRIFU	GE MOISTURE EQV: ASTM Method I	D 425-79	

Sample Num	ber: <u>86-</u>	09-309-04A	Client I.D.:	GMW-3 SS-4
PARTICLE S	IZE ANALYSIS	; ASTM Method D	422	
Specifi	um Particle Siz c gravity if Hig ess	e h	or Low	
Sieve A	<b>Inalysis</b>			
Grain s	ize percentages	and descriptions		Percentages
		d on No. 4 Sieve;		
C	oarse sand-(Re	tained on No. 10 S	iieve; 2.0mm)	
M D		etained on No. 40		
F.	ine Sand-(Retai escription:	ned on No. 200 Sie	eve; 0.075mm)	
Te	otal Sand:			
Hydrom	eter Analysis			
Soil wa soaking	s dispersed in 16 hours in sod	apparatus A for ium hexametapho:	one minute after sphate solution.	
C	lt-(.074mm to . lay-(.005mm to olloids-(Less the otal Silt/Clay/C	.001mm) an .001mm)		
SPECIFIC GR	AVITY: ASTM	Method D854	•••	
		Method	pcf-wet	
ATTERBERG	TESTS: ASTM	Method D4318-84	ı	
Plastic	Limit 81 Limit 25 Index 56			
PERCENT MO	DISTURE: AST	M Method D 2216-	-80	
CENTRIFUGE	MOISTURE E	QV: ASTM Method	d D 425-79	

Sample Numl	er: <u>36-09-309-35A</u> CI	lient I.D.:	GMW-3 ST-1
PARTICLE S	IZE ANALYSIS; ASTM Method D422		
Specifi	or Particle Size 1.5mm c gravity if High or less Soft and cohesive when wet.	Low	
Sieve /	Analysis		_
Grain s	ize percentages and descriptions		Percentages
	iravel-(Retained on No. 4 Sieve; 4.75m Description:		
	Coarse sand-(Retained on No. 10 Sieve; Description:		
Ε	Medium sand-(Retained on No. 40 Sieve Description: Mostly quartz, with I and limestone grains, subangular to su	; 0.425mm) imonitic	3
F	ine Sand-(Retained on No. 200 Sieve; ( Description: Mostly quartz to subservings.	0.075mm) rounded	11
T	otal Sand:		14
Hydror	neter Analysis		
Soil w soakin	as dispersed in apparatus A for one global to the solution of	minute after te solution.	
(	ilt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:		41 6 39 36
SPECIFIC G	RAVITY: ASTM Method DS542.62 s	g/cm <sup>3</sup>	
UNIT WEIGH	HT: Volumetric Vethod 126.8 101.7	pcf-wet pcf-dry	
ATTERBER	G TESTS: ASTM Method D4318-84		
Plastic	Limit 55  Limit 14  Index 41		
PERCENT N	MOISTURE: ASTM Method D 2216-80	24.	7%
CENTRIFU	GE MOISTURE EQV: ASTM Method D	425-79 47	¢%

Sample Nun	nber:	86-09-309-05A	Client I.D.:	GMW-4 SS-1
PARTICLE	SIZE ANAI	YSIS; ASTM Method	d D422	-
Specia	num Partic fic gravity ess	if High	or Low	
Sieve	Analysis			
Grain	size perce	ntages and description	ons .	Percentages
		etained on No. 4 Siev	ve; 4.75mm)	
		d-(Retained on No. )	10 Sieve; 2.0mm)	
		nd-(Retained on No.	40 Sieve; 0.425mm)	***************************************
1	Fine Sand-( Description	Retained on No. 200	Sieve; 0.075mm)	
•	Total Sand:			
Hydro	meter Ana	lysis		
		ed in apparatus A in sodium hexameta	for one minute after phosphate solution.	
. (	Clay-(.005r Colloids-(L	m to .005mm) nm to .001mm) ess than .001mm) Clay/Colloids:		
SPECIFIC C	RAVITY:	ASTM Method D854		
UNIT WEIG	<b>HT:</b> Volum	etric Method 1	01.7 pcf-wet 85.5 pcf-dry	
ATTERBER	G TESTS:	ASTM Method D431	8-84	
Plasti	Limit c Limit c Index			
PERCENT !	MOISTURE	: ASTM Method D 2	216-80	-
CENTRIFU	GE MOISTU	JRE EQV: ASTM Me	thod D 425-79	

Sample Numb	er: <u>86-09-3</u>	09-06A C	lient I.D.:	GMW'-4 SS-4	
PARTICLE S	ZE ANALYSIS; AS	TM Method D422			
Specifi	m Particle Size c gravity if High ss Soft and co		Low	and the same of th	
Sieve A	nalysis				
Grain s	ze percentages and	descriptions		Percentages	
	ravel-(Retained on escription:	No. 4 Sieve; 4.75n			
D		ed on No. 10 Sieve; ngular limestone fra		1	
D		ned on No. 40 Sieve ostly quartz grains ed.		4	
	Fine Sand-(Retained on No. 200 Sieve; 0.075mm)  Description:  Same as medium sand.				
To	tal Sand:			28	
Soil wa		aratus A for one hexametaphosphat			
C	t-(.074mm to .005 ay-(.005mm to .00 bloids-(Less than . btal Silt/Clay/Colle	Imm) 001mm)		$ \begin{array}{r}     31 \\     \hline     11 \\     \hline     30 \\     \hline     72 \end{array} $	
SPECIFIC GRAVITY: ASTM Method D854					
UNIT WEIGHT: Volumetric Method pcf-wet pcf-dry					
ATTERBERG TESTS: ASTM Method D4318-84					
Liquid 1 Plastic Plastic	Limit				
PERCENT M	DISTURE: ASTM \	!ethod D 2216-80_			
CENTRIFUG	CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79				

Sample Number:	36-09-309-36A	_ Client I.D.:	GMW-4 ST-1
PARTICLE SIZE AN	IALYSIS; ASTM Method [	0422	
Maximum Par Specific gravi Hardness	ticle Size 3.5mm ty if High Soft and cohesive when w	or Low	
Sieve Analysis	<b>;</b>		
	centages and descriptions	3	Percentages
Gravel-( Descript	Retained on No. 4 Sieve;	4.75mm)	0
Descript	and-(Retained on No. 10 ion: Subangular to subangular to subangular to subangular to subattered limonitic grains.	prounded quartz	
Descript	sand-(Retained on No. 40 ion:  Subangular to grains.	subrounded	4
Descript	d-(Retained on No. 200 Si ion: <u>Mostly subangula</u> grains.	r to subrounded	17
Total Sar			22
Hydrometer Ai Soil was dispe soaking 16 hou	nalysis ersed in apparatus A for rs in sodium hexametapho	one minute after osphate solution.	
Clay-(.00 Colloids-	mm to .005mm) 5mm to .001mm) (Less than .001mm) t/Clay/Colloids:		34 6 38 73
SPECIFIC GRAVITY	: ASTM Method D854	2.46 g/cm <sup>3</sup>	
UNIT WEIGHT: Valu	metric Method 122		
ATTERBERG TESTS	: ASTM Method D4318-8	4	•
Liquid Limit Plastic Limit Plastic Index	48 15 33		
PERCENT MOISTUR	E: ASTM Method D 2216	i-80 <u>19.7</u>	<u> </u>
CENTRIFUGE MOIS	TURE EQV: \STM Metho	od D 425-79 419	%

Sample Number	: \$6-09-309-07A	Client I.D.:	GMW-5 SS-1
PARTICLE SIZ	E ANALYSIS; ASTM Method D	422	
Maximum Specific Hardness	Particle Size 1.9mm gravity if High Soft, cohesive when wet	or Low	·-
Sieve Ana	alysis		
Grain siz	e percentages and descriptions		Percentages
	vel-(Retained on No. 4 Sieve; cription:		
	rse sand-(Retained on No. 10 S	•	
Des	fium sand-(Retained on No. 40 cription: Quartz grains h limonitic "ironstone" fragme	Sieve; 0.425mm) , subrounded	1
Des	• Sand-(Retained on No. 200 Si cription: Same as above e quartz.		4
Tot	al Sand:		5
Hydrome	er Analysis		
	dispersed in apparatus A for 6 hours in sodium hexametapho		
Cla Col	-(.074mm to .005mm) y-(.005mm to .001mm) loids-(Less than .001mm) al Silt/Clay/Colloids:		67 13°3 13°3 95
SPECIFIC GRA	VITY: ASTM Method D854		
UNIT WEIGHT	Volumetric Method 106		
ATTERBERG T	ESTS: ASTM Method D4318-8	34	
Liquid Li Plastic L Plastic In	imit	•	
PERCENT MOI	STURE: ASTM Method D 221	6-80	
CENTRIFUGE	MOISTURE EQV: ASTM Meth	od D 425-79	

Sample Nu	mber:	\$6_09_309_08A	_ Client I.D.:	GMW-5 SS-5
PARTICLE	SIZE ANALY	(SIS; ASTM Method [		
Speci	num Particle fic gravity if ness	High	or Low	
Sieve	Analysis			
Grain	size percent	ages and descriptions	<b>.</b>	Percentages
	Gravel-(Retail Description:	ained on No. 4 Sieve;	4.75mm)	
	Description:	(Retained on No. 10		
	Medium sand	-(Retained on No. 40	Sieve: 0.425mm)	
	Fine Sand-(Red Description:	etained on No. 200 Si	ieve; 0.075mm)	
	Total Sand:			
Hydro	meter Analys	is		
Soil w soakin	as dispersed g 16 hours in	in apparatus A for sodium hexametapho	one minute after osphate solution.	
	Silt-(.074mm Clay-(.005mm Colloids-(Less Fotal Silt/Cla	n to .001mm) s than .001mm)		
SPECIFIC G	RAVITY: A5	TM Method D854	·	-
		ric Method	···	
ATTERBER	G TESTS: AS	TM Method D4318-8	4	
Liquid Plastic Plastic	Limit Limit Index	31 17 14		
PERCENT A	OISTURE: A	ASTM Method D 2216	i-80	
			od D 425-79	

Sample Numi	ber: <u>\$6-09-309-37A</u>	Client I.D.:	GMW-5 ST-1
PARTICLE S	IZE ANALYSIS; ASTM Method D42	2	
Specifi	um Particle Size	or Low	
Sieve A	Analysis		
Grain s	ize percentages and descriptions		Percentages
	iravel-(Retained on No. 4 Sieve; 4. Description:		
	Coarse sand-(Retained on No. 10 Siew Description: Subrounded limest		
D	ledium sand-(Retained on No. 40 Sie escription: <u>Mostly subrounded</u> scattered limestone and limonitic g	quartz with	4
	ine Sand-(Retained on No. 200 Sieve escription: Same as ab		21
T	otal Sand:		26
Hydron	neter Analysis		
	is dispersed in apparatus A for or 16 hours in sodium hexametaphosp		
C	ilt-(.074mm to .005mm) lay-(.005mm to .001mm) olloids-(Less than .001mm) otal Silt/Clay/Colloids:		31 9 34 74
SPECIFIC GF	RAVITY: ASTM Method D8542.6	2 g/cm	
UNIT WEIGH	T: Volumetric Method 132.6		
ATTERBERG	TESTS: ASTM Method D4318-84		
	Limit 44 Limit 15 Index 29		
PERCENT M	OISTURE: ASTM Method D 2216-8	0 18.79	<u> </u>
CENTRIFUG	E MOISTURE EQV: ASTM Method	D 425-79 34%	

Sample Nur	nber:	\$6-29-309-38A	Client I.D.:	GMW-6 ST-1	
PARTICLE	SIZE AN	ALYSIS; ASTM Method D	422		
Speci	fic gravi	ticle Size 0.8mm ty if High Soft and cohesive when we	or Low		
Sieve	Analysis				
Grain	size per	centages and descriptions		Percentages	
	Gravel-( Descript	Retained on No. 4 Sieve; ion:	•		-
	Coarse s Descript	and-(Retained on No. 10 sion:	Sieve; 2.0mm)		-
	Descript	sand-(Retained on No. 40 ion: Crinoid fragments, partz-all angular to suban	chert fragments		-
	Descript	d-(Retained on No. 200 Si ion: Mostly subangular monitic grains present	eve; 0.075mm) quartz and chert	13	-
	Total Sai	nd:		13	_
Soil v soakir	Silt-(.074 Clay-(.00 Colloids-	ersed in apparatus A for rs in sodium hexametapho (5mm to .005mm) (55mm to .001mm) (Less than .001mm) (1/Clay/Colloids:		28 17 37 32	- - -
SPECIFIC O	GRAVITY	: ASTM Method D8542	.66 g/cm <sup>3</sup>		
UNIT WEIG	HT: Vol	umetric Method 121.	pcf-wet pcf-dry		
ATTERBER	G TESTS	: ASTM Method D4318-8	4		
Plasti	d Limit c Limit c Index	42 14 28			
PERCENT	MOISTU	RE: ASTM Method D 2216	5-30	18.6%	
CENTRIFU	GE MOIS	TURE EQV: ASTM Metho	od D 425-79	34%	

Sample Numb	er: <u>86-09-309-09A</u>	Client I.D.:	GMW'-7 SS-1
PARTICLE S	IZE ANALYSIS; ASTM Method D42	22	
Sp <b>e</b> cifi	m Particle Size c gravity if High ss	or Low	·
Sieve A	nalysis		
Grain s	ize percentages and descriptions		Percentages
G D	ravel-(Retained on No. 4 Sieve; 4. escription:	.75mm)	
C	parse sand-(Retained on No. 10 Sie escription:		
<b>M</b> D	edium sand-(Retained on No. 40 Si escription:	eve; 0.425mm)	
Fi Do	ne Sand-(Retained on No. 200 Sievescription:	e; 0.075mm)	
To	tal Sand:		
Hydrom	eter Analysis		
Soil wa soaking	s dispersed in apparatus A for o 16 hours in sodium hexametaphosp	ne minute after hate solution.	
CI Cc	t-(.074mm to .005mm) ay-(.005mm to .001mm) olloids-(Less than .001mm) tal Silt/Clay/Colloids:		
SPECIFIC GR	AVITY: ASTM Method D854		-
UNIT WEIGHT	7: Volumetric Method 122.7 101.6	pcf-wet pcf-dry	
ATTERBERG	TESTS: ASTM Method D4318-84		
Plastic	imit _imit ndex		
PERCENT MO	DISTURE: ASTM Method D 2216-8	0	
CENTRIFUGE	MOISTURE EQV: ASTM Method	D 425-79	•••

Sample Nu	mber:	86-09-309-10A	Client I.D.:	GMW-7 SS-6
PARTICLE	SIZE ANAI	YSIS; ASTM Method D	422	
Spec	ific gravity	le Size 4.7mm if High 2.69 ft and cohesive when w	or Low	
	Analysis			_
Grai	n size perce	ntages and descriptions	,	Percentages
	Gravel-(Re	etained on No. 4 Sieve; n:		·
	Coarse san Description angular		•	1
		nd-(Retained on No. 40 n: <u>Most quar</u> rounded.	•	5
		Retained on No. 200 Sign:same as me		20
	Total Sand			25
Hydr	ometer Ana	lysis		
		ed in apparatus A for in sodium hexametapho		er
	Clay-(.005r Colloids-(L	m to .005mm) nm to .001mm) ess than .001mm) Clay/Colloids:		34 9 32 75
SPECIFIC	GRAVITY:	ASTM Method D854	<u></u>	
UNIT WEI	GHT: Volum	netric Method	pcf-wet	
ATTERBE	RG TESTS:	ASTM Method D4318-8	4	
Plas	id Limit tic Limit tic Index			
PERCENT	MOISTURE	: ASTM Method D 2216	5-80	
CENTRIF	JGE MOIST	JRE EQV: ASTM Metho	od D 425-79	

Sample Number:	86-09-309-11A	_ Client I.D.:	GMW-7 SS-9
PARTICLE SIZE	ANALYSIS; ASTM Method D	422	
Specific gr	Particle Size 4.7mm avity if High Soft and cohesive when we	or Low	
Sieve Anal	<u>ysis</u>		
Grain size	percentages and descriptions		<u>Percentages</u>
	el-(Retained on No. 4 Sieve; ription:		
	se sand-(Retained on No. 10 Stription: Mostly cher		1
	um sand-(Retained on No. 40 ription: Mostly quartz		3
	Sand-(Retained on No. 200 Siription: Mostly quartz		2
Total	Sand:		6
Hydromete	r Analysis		
	ispersed in apparatus A for hours in sodium hexametapho		
Clay- Collo	.074mm to .005mm) -(.005mm to .001mm) ids-(Less than .001mm) Silt/Clay/Colloids:	•	59 8 27 94
SPECIFIC GRAV	TTY: ASTM Method D854		
UNIT WEIGHT:	Volumetric Method 126	pcf-wet pcf-dry	
ATTERBERG TE	STS: ASTM Method D4318-8	34	
Liquid Lim Plastic Lin Plastic Ind	nit		
PERCENT MOIS	TURE: ASTM Method D 221	6-80	· ·
CENTRIFUGE M	IOISTURE EQV: ASTM Meth	od D 425-79	

Sample Number:	\$6-09-309-31A	Client I.D.:	GMW-7 ST-1
PARTICLE SIZE	ANALYSIS; ASTM Method I	D422	
Specific gra	Particle Size 3.0mm avity if High Soft, cohesive when we	or Low	
Sieve Analy	rsis		
Grain size j	percentages and descriptions	s	Percentages
<b>Grave</b> Descr	el-(Retained on No. 4 Sieve; iption:		0
Coars Descr	e sand-(Retained on No. 10 iption: Angular cher	Sieve; 2.0mm) t fragments	1
Descri	m sand-(Retained on No. 40 iption: L.S. qtz., brown ents, subangular.	Sieve; 0.425mm) limonitic rock	2
Fine S Descri	and-(Retained on No. 200 Single on Mostly quartz	ieve: 0.075mm) z subangular.	99
Total :	Sand:		_ 12
Hydrometer	Analysis		
Soil was dis soaking 16 h	spersed in apparatus A for ours in sodium hexametapho	one minute after osphate solution.	
Clay-(, Colloid	074mm to .005mm) .005mm to .001mm) ds-(Less than .001mm) Silt/Clay/Colloids:		42 3 43 38
	_	2.64 g/cm <sup>3</sup>	
UNIT WEIGHT: V	<del></del>	9pcf-wet	
ATTERBERG TES	TS: ASTM Method D4318-8	4	
Liquid Limit Plastic Limi Plastic Index	t13		
PERCENT MOIST	URE: ASTM Method D 2216	-8024.6	
CENTRIFUGE MO	ISTURE EQV: ASTM Metho	od D 425-79 46%	

Sample Numi	er: <u>\$6-09-309-12A</u>	Client I.D.:	GMW'-8- SS-1
PARTICLE S	IZE ANALYSIS; ASTM Method D4	22	
Specifi	um Particle Size 10mm c gravity if High ss Soft & cohesive when wet	or Low	<del></del>
Sieve A	nalysis		
Grain s	ize percentages and descriptions		Percentages
<b>G</b>	ravel-(Retained on No. 4 Sieve; escription: Limestone a	4.75mm) nd slag	
D	oarse sand-(Retained on No. 10 Si escription: <u>Limestone, wh</u> wartz-subangular.	ite chert	20
м	edium sand-(Retained on No. 40 Sescription: Mostly qu	iieve; 0.425mm)	17
	ne Sand-(Retained on No. 200 Sie	ve; 0.075mm)	11
To	tal Sand & Gravel:	·	68
Hydrom	eter Analysis		
Soil wa soaking	s dispersed in apparatus A for ( 16 hours in sodium hexametaphos	one minute after phate solution.	
Ci Co	t-(.074mm to .005mm) ay-(.005mm to .001mm) bloids-(Less than .001mm) tal Silt/Clay/Colloids:	·	19 3 5 32
SPECIFIC GR	AVITY: ASTM Method D854	54 g/cm <sup>3</sup>	
UNIT WEIGHT	7: Volumetric Method	pcf-wet pcf-dry	
ATTERBERG	TESTS: ASTM Method D4318-84	·	
Liquid L Plastic I Plastic I	imit	•	
PERCENT MO	DISTURE: ASTM Method D 2216-	80	
CENTRIFUGE	MOISTURE EQV: ASTM Method	D 425-79	

Sample Num	sber: <u>\$6-09-309-32A</u>	Client I.D.:	GMW-8- ST-1
PARTICLE	SIZE ANALYSIS; ASTM Method D4	22	
Specif	num Particle Size 7.3mm ic gravity if High ess Soft & cohesive when wet	or Low 2.37	
Sieve	Analysis		
Grain	size percentages and descriptions		Percentages
	Gravel-(Retained on No. 4 Sieve; 4 Description: Limestone fragn asphalt film., angular.		4
I	Coarse sand-(Retained on No. 10 Sie Description: Same as above voluments.	with some	3
E	Medium sand-(Retained on No. 40 Si Description: Quartz, chert, and asphalt film.	eve; 0.425mm) zular, some	6
F D	ine Sand-(Retained on No. 200 Sievescription:		13
т	otal Sand & Gravel:		26
Hydron	neter Analysis		
Soil wa soaking	as dispersed in apparatus A for o 16 hours in sodium hexametaphosp	ne minute after shate solution.	
C	ilt-(.074mm to .005mm) lay-(.005mm to .001mm) folloids-(Less than .001mm) otal Silt/Clay/Colloids:		35 8 31 74
SPECIFIC GE	RAVITY: ASTM Method D854 2.3	7 g/cm <sup>3</sup>	
	T: Volumetric Method 113.3	pcf-wet	
ATTERBERG	TESTS: ASTM Method D4318-84		
Liquid I Plastic Plastic	Limit 16		
PERCENT M	OISTURE: ASTM Method D 2216-8	015.7	
	E MOISTURE EQV: ASTM Method		

Sample Number: 86 69 309 33A Client I.D.:	CMW-9 ST-1
PARTICLE SIZE ANALYSIS; ASTM Method D422	
Maximum Particle Size 3.2mm or Low Or Low Hardness Soft, cohesive when wet.	
Sieve Analysis	
Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm) Description:	
Coarse sand-(Retained on No. 10 Sieve; 2.0mm) Description:  Limestone fragments and quartz- angular.	
Medium sand-(Retained on No. 40 Sieve; 0.425mm)  Description:  Quartz, Subangular.	4
Fine Sand-(Retained on No. 200 Sieve; 0.075mm)  Description:  Quartz, angular	20
Total Sand:	25
Hydrometer Analysis	
Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.	
Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	35 11 29 75
SPECIFIC GRAVITY: ASTM Method D854	
UNIT WEIGHT: Volumetric Method 117.9 pcf-wet pcf-dry	
ATTERBERG TESTS: ASTM Method D4318-84	
Liquid Limit 41 Plastic Limit 15 Plastic Index 26	
PERCENT MOISTURE: ASTM Method D 2216-80 16.5%	
CENTRIFUGE MOISTURE EQV: ASTM Method D 425-79 37%	<del></del>

Sample Num	nber:	86-09-309-34A	Client I.D.:	GMW-10 ST-1
PARTICLE	SIZE ANALY	'SIS; ASTM Method	D422	
Specia	num Particle fic gravity if ness <u>Sc</u>	1111111	or Low	<del>-</del>
Sieve	Analysis			
Grain	size percent	ages and description	ns	Percentages
	Gravel-(Retail Description:	ained on No. 4 Sieve	•	0
	Coarse sand- Description:		9 Sieve; 2.0mm)	0
	Medium sand Description:	-(Retained on No. 4 Ouartz. ro	40 Sieve; 0.425mm) ounded grains	5
i	Description:	etained on No. 200 <u>Cuartz. some I</u>	Sieve; 0.075mm) imonitic sand and	20
•	Total Sand:			25
Soil w soakin	g 16 hours in Silt-(.074mm	in apparatus A f sodium hexametap	or one minute after hosphate solution.	<u>35</u>
•		s than .001mm)	·	29 7.5
SPECIFIC G	RAVITY: AS	TM Method D854 _		
UNIT WEIGI	HT: Volumet		17.7 pcf-wet 04.6 pcf-dry	
ATTERBER	G TESTS: A	STM Method D4318	-34	-
Plastic	Limit c Limit c Index	39 16 23		
PERCENT N	MOISTURE:	ASTM Method D 22	16-80 17	.2%
CENTRIFUC	GE MOISTUR	E EQV: ASTM Met	hod D 425-79 40	%

Sample Number	GMW-11 SS-1		
PARTICLE SIZ	E ANALYSIS; ASTM Method D	422	
Maximum Specific	Particle Size 2.8mm gravity if High Soft and cohesive when w	or Low	<del></del>
Sieve Ana	alysis		
Grain siz	e percentages and descriptions		Percentages
	wel-(Retained on No. 4 Sieve; cription:	•	
Coa Des	rse sand-(Retained on No. 10 S cription: Mostly subround	Sieve; 2.0mm) ded limestone	
Des	lium sand-(Retained on No. 40 cription: Mostly subrounded on its grains, some quartz	Sieve; 0.425mm) Limestone, and	1
	e Sand-(Retained on No. 200 Si cription: Same as		1
Tota	al Sand:		3
Hydromet	er Analysis		
Soil was soaking le	dispersed in apparatus A for 5 hours in sodium hexametapho	one minute after sphate solution.	
Clay Coll	(.074mm to .005mm) (-(.005mm to .001mm) oids-(Less than .001mm) al Silt/Clay/Colloids:		64 10 23 97
SPECIFIC GRA	VITY: ASTM Method D854		·
UNIT WEIGHT:	Volumetric Method 125.		
ATTERBERG T	ESTS: ASTM Method D4318-8	4	
Liquid Lir Plastic Li Plastic In	mit		
PERCENT MOIS	STURE: ASTM Method D 2216	-80	-
CENTRIFUGE I	MOISTURE EQV: ASTM Metho	od D 425-79	

Sample Number:	<u> 96-09-309-39A</u>	_ Client I.D.:	GMW'-11 ST-1
PARTICLE SIZE ANA	LYSIS; ASTM Method D	0422	
Maximum Partic Specific gravity Hardness <u>So</u>		or Low	1-11-5
Sieve Analysis			
Grain size perce	entages and descriptions	i	Percentages
Gravei-(R Descriptio	etained on No. 4 Sieve; n:	4.75mm)	
Descriptio	nd-(Retained on No. 10 :  There was only subangular limestone gr	0.2% coarse	1
Description	nd-(Retained on No. 40 n: <u>Mostly subangular</u> th trace limestone and	to subrounded	3
Fine Sand- Description	(Retained on No. 200 Sin: Same as		15
Total Sand	:		18
Hydrometer Ana	lysis		
Soil was dispers soaking 16 hours	ed in apparatus A for in sodium hexametapho	one minute after sphate solution.	
Clay-(.005r Colloids-(L	m to .005mm) nm to .001mm) ess than .001mm) Clay/Colloids:		$ \begin{array}{r} 31 \\ 15 \\ 41 \\ 32 \end{array} $
SPECIFIC GRAVITY:	ASTM Method D854 <u>2</u>	.55 g/cm <sup>3</sup>	
UNIT WEIGHT: Volum		7 pcf-wet	
ATTERBERG TESTS:	ASTM Method D4318-8	4	
Liquid Limit Plastic Limit Plastic Index	58 14 44		
PERCENT MOISTURE	: ASTM Method D 2216	-8023.3	<u>%</u>
CENTRIFUGE MOISTL	JRE EQV: ASTM Metho	d D 425-79419	6

Sample Number: 36-09-310-06A Cheft I.D.: GM	W-12-31-1
PARTICLE SIZE ANALYSIS; ASTM Method D422	
Maximum Particle Size 25mm  Specific gravity if High or Low  Hardness Soft and cohesive when wet.	-
Sieve Analysis	
Grain size percentages and descriptions	Percentages
Gravel-(Retained on No. 4 Sieve; 4.75mm)  Description: 3/4" Claystone. No. 4  claystone and chert, angular.	
Coarse sand-(Retained on No. 10 Sieve; 2.0mm)  Description: Chert, angular	2
Medium sand-(Retained on No. 40 Sieve; 0.425mm)  Description:  Quartz and chert	5
Fine Sand-(Retained on No. 200 Sieve; 0.075mm)  Description: Quartz with some chert  subrounded limonitic grains.	7
Total Sand & Gravel:	24
Hydrometer Analysis	
Soil was dispersed in apparatus A for one minute after soaking 16 hours in sodium hexametaphosphate solution.	
Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	63 2 11 76
SPECIFIC GRAVITY: ASTM Method D854 2.59 g/cm <sup>3</sup>	
UNIT WEIGHT: Volumetric Method 99.9 pcf-wet 73.3 pcf-dry	
ATTERBERG TESTS: ASTM Method D4313-84	
Liquid Limit 50 Plastic Limit 18 Plastic Index 32	·
PERCENT MOISTURE: ASTM Method D 2216-80 25.7%	
CENTRIFUGE MOISTURE EQY: ASTM Method D 425-79	

# SOILS ANALYSIS CHEMICAL TEST

Sample Number:	<b>8</b> 609310-06A	Client I.D.:	GMW-12 ST-1
CATION EXCHANGE	E CAPACITY; Hoddinott Me	thod	
Exchange Acid	ity, meq/100g o.d. soil =	27.63	_
Exchange Catio	on Content, meq/100g o.d. so	oil (Ca) =	24.09
		(Mg)=	7.54
		(K) =	0.42
		(Na) =	0.52
	tive cation exchange capacit	y, meq/100g o	.d. soil.

DISTRIBUTION RATIOS; Method D-4320-84 - See separate report.

Sample Number: 86-09-309-14A Client I.D.			Client I.D.:	GMW-13 SS-4
PARTICLE S	SIZE ANALY	'SIS; ASTM Method	D422	
Specif	um Particle ic gravity if ess	High	or Low	·
Sieve	Analysis			
Grain:	size percent	ages and descriptio	ns	Percentages
( I	Gravel-(Reta Description:	ained on No. 4 Sieve	e; 4.75mm)	
C	Coarse sand- Description:			
	Medium sand- Description:		40 Sieve; 0.425mm)	
<b>F</b>	ine Sand-(Re	etained on No. 200	Sieve; 0.075mm)	
τ	otal Sand:			
	neter Analys			
Soil wa soaking	as dispersed ; 16 hours in	in apparatus A f sodium hexametap	or one minute after hosphate solution.	
C	ilt-(.074mm lay-(.005mm lolloids-(Less otal Silt/Cla	to .001mm) s than .001mm)		
SPECIFIC G	RAVITY: AS	TM Nethod D854 _	2.68 g/cm <sup>3</sup>	
UNIT WEIGH	T: Volumet	ric Method	pcf-wet	
ATTERBERO	TESTS: AS	TM Method D4318	-34	
Liquid Plastic Plastic	Limit -			
PERCENT M	OISTURE: A	ASTM Method D 22	16-80	
CENTRIFUG	E MOISTUR	E EQV: ASTM Met	hod D 425-79	

Sample Nu	16-09-310-07A	Client I.D.:	GMW-13 ST-1
PARTICLE	SIZE ANALYSIS; ASTM Met	hod D422	
Spec	mum Particle Size0_5m ific gravity if High nessSoft and cohesive w	or Low	
Sieve	Analysis		
Graii	n size percentages and descrip	otions	Percentages
	Gravel-(Retained on No. 4 S Description:	ieve; 4.75mm)	
	Coarse sand-(Retained on No Description:	o. 10 Sieve; 2.0mm)	
	Medium sand-(Retained on N Description: Subangular and quartz, and limonitic grains.	o. 40 Sieve; 0.425mm)	1
	Fine Sand-(Retained on No. 2 Description: Mostly angular limestone and impositic grain	200 Sieve; 0.075mm)	6
	Total Sand:		7
Hydro	meter Analysis		· · · · · · · · · · · · · · · · · · ·
Soil v soakir	was dispersed in apparatus Ang 16 hours in sodium hexame	A for one minute after taphosphate solution.	г
	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:		48 8 37
SPECIFIC C	RAVITY: ASTM Method D85	42.66 g/cm <sup>3</sup>	
	HT: Volumetric Method	121.4 pcf-wet 161.9 pcf-dry	
ATTERBER	G TESTS: ASTM Method D43	13-34	
Plasti	Limit		
PERCENT A	MOISTURE: ASTM Method D	2216-80	23.8
CENTRIFU	GE MOISTURE EQV: ASTM A	lethod D 425-79	•••

# SOILS ANALYSIS CHEMICAL TEST

Sample Number:	8609310-07A	Client I.D.:	GMW-13 ST-1
CATION EXCHANGE	CAPACITY; Hoddinott Me	thod	
Exchange Acidi	ty, meq/100g o.d. soil =	32.42	
Exchange Catio	n Content, meq/100g o.d. so	oil (Ca) =	17.84
		(Mg)=	8.92
	*	(K) =	0.25
		(Na) =	1.01
ECEC =6	ive cation exchange capacit  0.4  OS; Method D-4320-84 - See	·	

Sample Nun	nber:	86-09-309-40A	Client I	.D.:	GMW-14-ST-1
PARTICLE	SIZE ANAL	YSIS; ASTM Method D	422		
Specia	num Particl fic gravity i ness <u>Sof</u>		or Low _		
Sieve	Analysis				
Grain	size percen	tages and descriptions			Percentages
	<b>Gravel-</b> (Re Description	tained on No. 4 Sieve;	•		
	<b>Description</b> :	-(Retained on No. 10 S Mostly subangular ne limestone possibly d	chert, quar		1
1	Description:	4-(Retained on No. 40)  Same as above, limonitic grains scatt	also some		3
I I	Fine Sand-(F Description:	Retained on No. 200 Sie Same as		n)	12
1	Total Sand:				16
Soil w soakin	g 16 hours in Silt-(.074mm Clay-(.005m Colloids-(Le	tsis  d in apparatus A for sodium hexametaphos  a to .005mm)  m to .001mm)  ss than .001mm)  ay/Colloids:	one minute sphate solut	after ion.	32 17 42
		5TM Method D8542.	68 g/cm <sup>3</sup>		
UNIT WEIGH	dT: Volume	tric Method 121. 98.2			
ATTERBER	G TESTS: A	STM Method D4318-84			
	Limit Limit Index	53 14 39			
PERCENT N	OISTURE:	ASTM Method D 2216-	80 <u></u>	23.3%	
CENTRIFUC	E MOISTUI	RE EQV: ASTM Method	d D 425-79_	45%	

Sample Nu	mber:	86-09-309-15A	Client I.D.:	GMW'-1	5 SS-1
PARTICLE	SIZE ANA	L <b>YSIS;</b> ASTM Met	hod D422		
Speci	ific gravity	cle Size 3.0mr if High Soft, cohesive whe	or Low		
Sieve	Analysis				
Grain	size perce	entages and descrip	ptions	Perc	centages
	Gravel-(R Description	etained on No. 4 S	iieve; 4.75mm)	· -	0
	Descriptio	n: <u>Mostly a</u>	o. 10 Sieve; 2.0mm) rgillite fragments	-  	Trace
			lo. 40 Sieve; 0.425mm me as above		1
	Fine Sand- Descriptio	(Retained on No. 3	200 Sieve; 0.075mm) me as above	<u>-</u>	2
	Total Sand	:		<del>-</del> -	3
Hydro	meter Ana	lysis			
Soil v soakir	was dispers ng 16 hours	sed in apparatus . in sodium hexame	A for one minute af taphosphate solution.	ter	
	Clay-(.005 Colloids-(L	nm to .005mm) mm to .001mm) .ess than .001mm) Clay/Colloids:		- - -	59 7 31 97
SPECIFIC C	GRAVITY:	ASTM Method D85	54		
UNIT WEIG	HT: Volum	netric Method	92.8 pcf-wet 86.6 pcf-dry	and in small	ved partly dried volume so results
ATTERBER	G TESTS:	ASTM Method D4	318-84		from those obtained , larger sample
Plasti	d Limit c Limit c Index				
PERCENT	MOISTURE	: ASTM Method D	2216-80		
CENTRIFU	GE MOIST	URE EQV: ASTM	Method D 425-79	•••	<del></del>

Sample No	umber: <u>\$6-09-309-19A</u> Client	I-D.:GMW-18_SS-1
PARTICLE	E SIZE ANALYSIS; ASTM Method D422	
Spec	cimum Particle Size 12mm cific gravity if High 2,72 or Low dows Soft & cohesive when wet	***
Sieve	re Analysis	
Grai	in size percentages and descriptions	Percentages
	Gravel-(Retained on No. 4 Sieve; 4.75mm) Description: Limestone pebbles	9%
	Coarse sand-(Retained on No. 10 Sieve; 2.0mm Description:	
	Medium sand-(Retained on No. 40 Sieve; 0.425 Description: Same as above	imm)
	Fine Sand-(Retained on No. 200 Sieve; 0.075m Description:	
	Total Sand & Gravel:	17
	ometer Analysis	
soaki	was dispersed in apparatus A for one minute ing 16 hours in sodium hexametaphosphate solut	e after ion.
	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:	- 49 - 7 - 27 - 33
SPECIFIC (	GRAVITY: ASTM Method D854	
UNIT WEIG	GHT: Volumetric Method pcf-w	vet Iry
ATTERBER	RG TESTS: ASTM Method D4318-84	
Plasti	id Limit tic Limit tic Index	
PERCENT	MOISTURE: ASTM Method D 2216-80	
	JGE MOISTURE EQV: ASTM Method D 425-79	

Sample Nur	nber: <u> </u>	Client I.D.:	GMW-18 SS-2
PARTICLE	SIZE ANALYSIS; ASTM Metho	od D422	
Speci	num Particle Size fic gravity if High ess	or Low	<del></del>
Sieve	Analysis		
Grain	size percentages and descript	ions	Percentages
	Gravel-(Retained on No. 4 Sie Description:	eve; 4.75mm)	
	Coarse sand-(Retained on No. Description:	10 Sieve; 2.0mm)	
	Medium sand-(Retained on No. Description:	. 40 Sieve; 0.425mm)	
1	Fine Sand-(Retained on No. 20 Description:	0 Sieve; 0.075mm)	
•	Total Sand:		
Hydro	meter Analysis		
Soil w soakin	as dispersed in apparatus A g 16 hours in sodium hexameta	for one minute after aphosphate solution.	
	Silt-(.074mm to .005mm) Clay-(.005mm to .001mm) Colloids-(Less than .001mm) Total Silt/Clay/Colloids:		
SPECIFIC G	RAVITY: ASTM Method D854	2.67 g/cm <sup>3</sup>	<del></del>
	IT: Volumetric Method	•	
ATTERBER	G TESTS: ASTM Method D431	3-84	
Liquid Plastic Plastic	Limit Limit : Index		
PERCENT N	OISTURE: ASTM Method D	2216-80	
CENTRIFUC	E MOISTURE EQV: ASTM M	ethod D 425-79	

Sample Number:	86-09-310-08A	Client I.D.:	GMW-18 ST-1
PARTICLE SIZE AN	NALYSIS; ASTM Method D4	422	
Specific gravi	ticle Size	or Low	<u> </u>
Sieve Analysis	<u>s</u>		
Grain size per	centages and descriptions		Percentages
Gravel- Descript	(Retained on No. 4 Sieve;	•	
Coarse s Descriptquartz	and-(Retained on No. 10 Si ion: Angular to subar	eve; 2.0mm) ngular chert	
Medium Descript and_qua	sand-(Retained on No. 40 Sion: Subangular to subr	iieve; 0.425mm)	4
Fine San Descript	d-(Retained on No. 200 Sieion:Mostly subangu		15
Total Sar	nd:		<u>20</u>
Hydrometer Ar	nalysis	•	
Soil was dispe soaking 16 hou	rsed in apparatus A for c rs in sodium hexametaphos	one minute after phate solution.	
Clay-(.00 Colloids-	mm to .005mm)  5mm to .001mm)  (Less than .001mm)  (/Clay/Colloids:		32 9 39
SPECIFIC GRAVITY	: ASTM Method D854	55 g/cm <sup>3</sup>	
UNIT WEIGHT: Volu		pcf-wet	
ATTERBERG TESTS	: ASTM Method D4318-84		
Liquid Limit Plastic Limit Plastic Index	55 16 39		
PERCENT MOISTUR	E: ASTM Method D 2216-8	30	<b>્</b>
CENTRIFUGE MOIST	TURE EQV: ASTM Method		•

# SOILS ANALYSIS CHEMICAL TEST

Sample Number:	8609310-08A	Client I.D.:	C1111-18 ST-1	_
CATION EXCHANGE	CAPACITY; Hoddinott	Jethod		
Exchange Acidi	ty, meq/100g o.d. soil = _	42.12		
Exchange Catio	n Content, meq/190g o.d.	soil (Ca) = (Mg) = (K) = (Na) =		
ECEC = effect ECEC =	ive cation exchange capa	city, meq/100g o.d	d. soil.	

DISTRIBUTION RATIOS; Method D-4320-84 - See separate report.

# DISTRIBUTION RATIOS BY THE SHORT-TERM BATCH METHOD

CEP obtained five soil core samples from Bechtel Corporation for testing of distribution ratios by the short-term batch method. This is ASTM Standard Test Method D4319-83. This is a measurement technique for determining the distribution ratio or degree of partitioning between the soil and a water solution containing the species of interest. The species of interest for this case was uranium. Several repetitions of this test were performed before one optimium uranium concentration was established. The results presented are for that concentration of uranium (10 mg/l). In addition, the chemical constituents leached from the soils on the first day of the test are also included.

#### Method

ASTM Method D4319-83 briefly consists of setting up a series of batch reactions between the soil to be tested and a contacting liquid containing the species of interest. The soil samples are pre-washed and treated if necessary and then mixed with the contact solution in a ratio of 4 parts solution to 1 part soil. Over a time period of 14 days or longer, the batch samples are analyzed for the concentration of the species of interest, the initial chemical constituents of the leach solution and a series of chemical parameters for determining the equilibrium conditions of the test. In this case, the samples were analyzed repeatedly for pH, Eh, and specific conductivity.

These are the results for the prepared batch samples. The sample identifications are as follows:

CEP #	Bechtel Identification		fication
<b>8</b> 609310 - 5A	GMW-2	ST-1	11.5-12.5
<b>8</b> 609310 - 6A	GMW-12	ST-1	10.0-11.5
<b>8</b> 609310 - 7A	GMW-13	ST-1	11.5-13.5
8609310 - 8A	GMW-18	ST-1	11.5-13.5
<b>8</b> 609310 <b>- 9</b> A	G-21	ST-1	16.5-18.5

#### Free Uranium

Sample #	Dates: 11/27	12/4	12/9	12/16
8609310 - 5A	0.423 mg/1	0.169	0.174	0.200
<b>8</b> 609310 <b>-</b> 6A	0.872	1.518	0.288	0.809
<b>8</b> 609310 - 7A	0.2209	1.391	0.654	0.636
8609310 - 8A	1.585	1.508	1.256	1.237
8609310 - 9A	0.881	1.147	0.348	0.981
Leach Sin.	10.440	10.540		

#### <u>Eh</u>

Sample #	Dates: 11/25	12/2	12/8	12/15
8609310 - 5A	+228 mv	277	389	424
<b>8</b> 609310 <b>-</b> 6A	162	253	366	413
8609310 - 7A	178	260	383	419
<b>8</b> 609310 <b>-</b> 8A	158	232	341	403
<b>8</b> 609310 <b>-</b> 9A	127	254	321	<b>3</b> 85
Leach Sin.	110	287	336	<b>3</b> 91

#### pН

Sample #	Dates: 11/25	_12/2	12/8	12/15
<b>86</b> 09310 - 5A	7.79	7.00	7.02	7.20
<b>8</b> 609310 - 6A	8.73	7.59	7.67	7.86
8609310 - 7A	8.58	7.98	7.20	7.30
8609310 - 8A	9.13	7.75	7.77	8.20
8609310 - 9A	<b>2</b> 72	<b>3</b> 06	335	341
Leach Sin.	7.65	7.35	7.31	7 10

#### Specific Conductivity

Sample #	Dates: 11/26	_12/2	12/8	12/15
8609310 - 5A	332 umhos/cm	388	409	445
8609310 - 6A	287	341	363	<b>3</b> 93
<b>8</b> 609310 - 7A	307	407	437	455
8609310 - 8A	<b>2</b> 82	331	372	<b>3</b> 83
8609310 - 9A	272	<b>3</b> 06	335	341
Leach Sin.	<b>2</b> 62	<b>2</b> 56	251	270

#### Test Conditions

Contact liquid (Leach Sln.): Deionized water containing 10 mg/l uranium

Initial pH: 7.65 Final pH: 7.10

Solid to liquid ratio: 200 grams soil/800 mls sln.

Contact time: 21 days

Equilibrating atmosphere: air

Contact solution filtered after centrifugation?: no

Soil sampe disaggregated?: yes

Particle size: approximately 5mm

H<sub>2</sub>0<sub>2</sub>treatment to remove organics?: no

Samples were mixed for six hours by rotation between analyses.

Additional data on the leached solution chemical parameters is shown under a separate report for CEP #8612233.

#### Distribution Ratio

$$R_{d=} \frac{(F_m) (V_s)}{(F_s) (W_m)}$$

where:

Rd= distribution ratio, mL/g

 $F_{s}$ = fraction of total activity in solution.

 $F_{\rm S}$  is found by dividing the the concentrations of the ion after the solution has come to equilibrium with the soil/rock fraction by the concentration of the ion before the solution was allowed to come to equilibrium with the soil fraction.

F<sub>m</sub>= fraction of activity sorbed into the solid residue.

$$F_{m}=1-F_{s}$$

 $V_{\text{S}}$ = volume of solution equilibrated with  $W_{m}$ , ml

W<sub>m=</sub> weight of solid residue, g

#### Sample Values

8609310 - 5A

$$R_{d} = \frac{(F_{m}) (V_{s})}{(F_{s}) (V_{m})}$$

$$F_{s=} = \frac{0.200 \text{ mg/l}}{10.440 \text{ mg/l}} = 0.0192$$

 $V_{\text{S}}$ = 800 mls leach solution  $W_{\text{m}}$ = 200 grams solid

$$R_{d} = \frac{(0.98) (300ml)}{(0.019) (200g)} = 207 \text{ ml/g}$$

8609310 - 6A

$$R_{c} = \frac{(0.939) (800 \text{ m1})}{(0.077) (200g)} = 47.7 \text{ m1/g}$$

8609310 - 7A

$$R_{d=} \frac{(0.939) 800 \text{ m1}}{(1.061) (200g)} = 61.6 \text{ m1/g}$$

8609310 - 8A

$$R_d = \frac{(0.906) (800 \text{ ml})}{(0.118) (200g)} = 29.9 \text{ ml/g}$$

8609310 - 9A

$$R_{d} = \frac{(0.906) (800 \text{ ml})}{(0.094) (200g)} = 38.6 \text{ ml/g}$$

Analytical Methods	_	
Calcium	EPA	200.7
Chloride	EPA	325.2
Iron	EPA	200.7
Potassium	EPA	258.1
Magnesium	EPA	200.7
Manganese	EPA	200.7
Sodium	EPA	273.1
Sulfate	EPA	375.4
Solids, Total Dissolved	EPA	160.1
Total alkalivity (as CaCo3)	EPA	310.1
<b>p</b> h	EPA	150.1
Eh	ASTM D1498-76	

EPA

ASTM D2907-75

120.1

Specific Conductance

Uranium

date of final report unless other arrangements are main These samples will be disposant of in three weeks from the CONTACT GAIL ENTIFIED BY DUI OF BIATE 800/545-2188 [AB # 86-12-233 PREPARED Controls for Environmental Pollution, Inc Santa Fe, NM 87507 1925 Rosina Street The Court of the state of the s PHC'4E (505) 982-9841 REPORT 01/06/87 09:46:19 ATTEN CEP, Inc SAMPLES 37831-0350 COMPANY Bechtel FACILITY 800 Dak Ridge Turnpike Dak Ridge, TN WORK ID Water Quality REPORT Bechtel
TO P.O. Box 350 ATTEN Mark Tardiff RECEIVED: 12/15/86 CLIENT BECHTEL PAGE 1

<b>D</b> -	
9 GAMPLE IDENTIFICATION	CEP, Inc. TEST CODES and NAMES used on this report
	CA 1 Calcius
02 CMW-12 CT-1 10. 0-11. 5	CL 1 Chloride
July-13 ST-1 11, 5-13, 5	FE 1 Iton
	K 1 Potassium
05 G-21 St-1 16.5-18.5	MG 1 Magnesiun
Blank	Mni 1 Hanganese
	NA 1 Sodium

Total Alfalinity (as CaCC3)

Total Dissolved Solids

Sultate

TDS 1 S04 W

т. С 1

INC

419612

Relog Water

TRANS 1YPE

TAKEN

C tr fo inversion of the contrary of the contr	ION DATE COLLECTED TYPE OF ANALYSIS  not specified Calcium Chloride Tron Fotassium Fot	1.5 not specified Calctum Chloride Iron Potassium Kagnesium Kanganese Sodium Solfate Solfate Total Alkalinity (as CaCD3)	13.5 not specified Calcium Chloride Iron Iron Fotassiun Hanganese Sodiun Sulfate Solids, Total Dissolved Total Alkalinity (as CaCD)	s not specified Calcium Chloride Iron Potassium Kagnesium
<b>0</b> -	SAMPLE IDENTIFICATION  OM -2 ST-1 11.5-12.5  not speci	3 O C	not sp	not spe

86-12-233

DUTUE STATE 800/545.2188	MQ/liter 13.4 <1 148	11.8 3.3 3.3 1.8 0.04 13.3 71	<ul> <li>44</li> <li>60.1</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li> <li>71.0</li></ul>
REPURT L AMALYSIS	>1088	Calcium Chloride Iron Potassium Magnesium Manganese Sodium Sultate Solids, Total Dissolved	Total Alkalinity (as CaCO3) Calcium Chloride Iron Potassium Maganese Sodium Sulfate Solids, Total Dissolved Total Alkalinity (as CaCO3)
rd '0r 'v'   X	DATE COLLECTED	not specified	not specified
PAGE 3	SAMPLE IDENTIFICATION GMW-18 ST-1 11. 5-13. 5	G-21 St-1 16.5-18.5	<b>D</b> D-69

# APPENDIX E ELECTROMAGNETIC TERRAIN CONDUCTIVITY SURVEY OF THE WELDON SPRING CHEMICAL PLANT GROUNDS

#### APPENDIX E

### ELECTROMAGNETIC TERRAIN CONDUCTIVITY SURVEY OF THE WELDON SPRING CHEMICAL PLANT GROUNDS

#### 1.0 INTRODUCTION AND PURPOSE

An Electromagnetic (EM) Terrain Conductivity Survey was performed at the Weldon Spring Site in February 1986 to identify the presence of conductive contaminant plumes in the site groundwater system and thereby provide information on which to base the selection of locations for groundwater monitoring wells.

#### 2.0 LOCATION AND SURVEY CONTROL

Figure E-l is a terrain conductivity contour map showing the areal limits of the survey. Initial horizontal control for the survey was established by the compass and line-of-sight methods. The survey lines were marked at each end (and at turning points where appropriate) by stakes which were subsequently surveyed relative to site coordinates.

#### 3.0 METHOD OF INVESTIGATION

The survey was performed using the Model EM 34-3 electromagnetic terrain conductivity meter manufactured by Geonics Limited of Ontario, Canada.

Conductivity data were obtained at a series of traverses concentrated in three areas at the site: the Ash Pond, the area to the north of the Weldon Spring Chemical Plant (WSCP), and the area to the east of the WSCP. Surveying of the WSCP property was prevented by electrical interference generated by power lines, overhead and underground metallic pipes, and metallic structures.

The instrumentation was placed in the horizontal dipole mode (vertical coil configuration) with an intercoil spacing of 20 m. The optimum intercoil spacing was determined on the basis of depth to groundwater as measured in geologic boreholes in the WSCP area. The 20-m intercoil was used to provide an exploration depth of 15 to 18 m.

#### 4.0 RESULTS AND INTERPRETATION

The results of the conductivity survey are presented in Figure E-1. Results of the survey are discussed separately for each of the three distinct areas referenced above (the Ash Pond and the areas to the north and to the east of the WSCP).

#### 4.1 ASH POND AREA

Contours in the Ash Pond area show generally low to moderate conductivity values, with the exception of four localized areas of high conductivity. The two areas of high conductivity in the central and southern central portions of the Ash Pond appear to be related to completely or partially buried metallic debris, including drums and scrap metal. The third area, located to the west of the Ash Pond, is an expression of the buried discharge line that conducts water from the Ash Pond to a surface drainage channel. The fourth area of high conductivity, located north of the Ash Pond, is an expression of a buried culvert. In general, terrain conductivities increase from southwest to northeast: the approximate direction of groundwater flow in the area.

#### 4.2 NORTH OF WSCP

Conductivities in the area to the north of the WSCP tend to decrease from south to north. While conductivities in the extreme northern portion of this area are among the lowest recorded at the site, the area immediately adjacent to the chemical plant exhibits the highest conductivity values. The 50-mmhos/m contour, which appears to

characterize the area occupied by the chemical plant, may indicate an area of degraded groundwater quality. The installation and sampling of groundwater monitoring wells.in this area will provide the information necessary to evaluate this hypothesis.

### 4.3 EAST OF WSCP

The area to the east of the WSCP exhibited the highest average conductivity of the three areas surveyed. The southern portion of this area exhibited conductivity values in excess of 60 mmhos/m. The distribution of the high conductivity zone along line EM-10 indicates two narrow areas of high conductivity, while the distribution along line EM-11 indicates a broader area of high conductivity. Based upon the geology of the area, it is possible that the high readings may be an expression of a solution feature.

### 5.0 RECOMMENDATIONS

It is recommended that two monitoring wells be relocated to provide additional data from the area of high conductivity to the east of the WSCP. The existing design locations of monitoring wells to the north of the WSCP are adequate to evaluate the potential for contamination of the groundwater in this area. A review of the site configuration, interferences, and directions of groundwater flow leads to the recommendation that additional electromagnetic terrain conductivity surveys are not needed at this time.

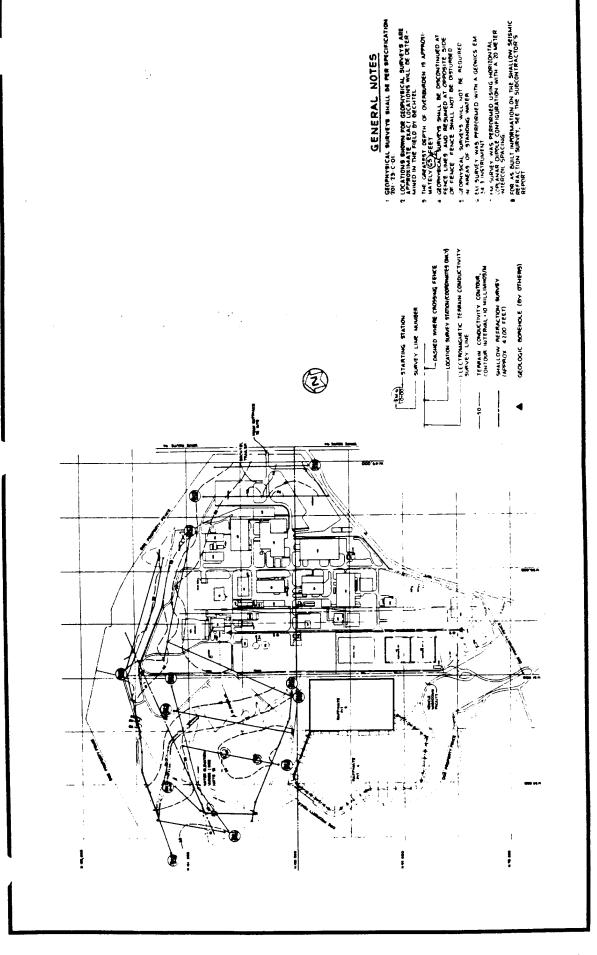
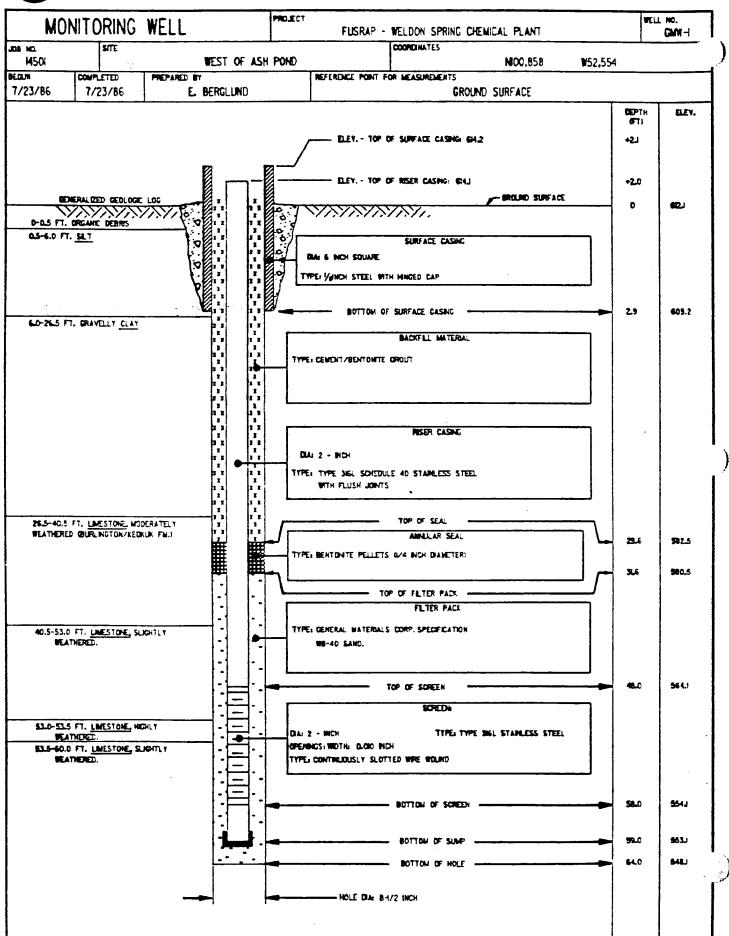


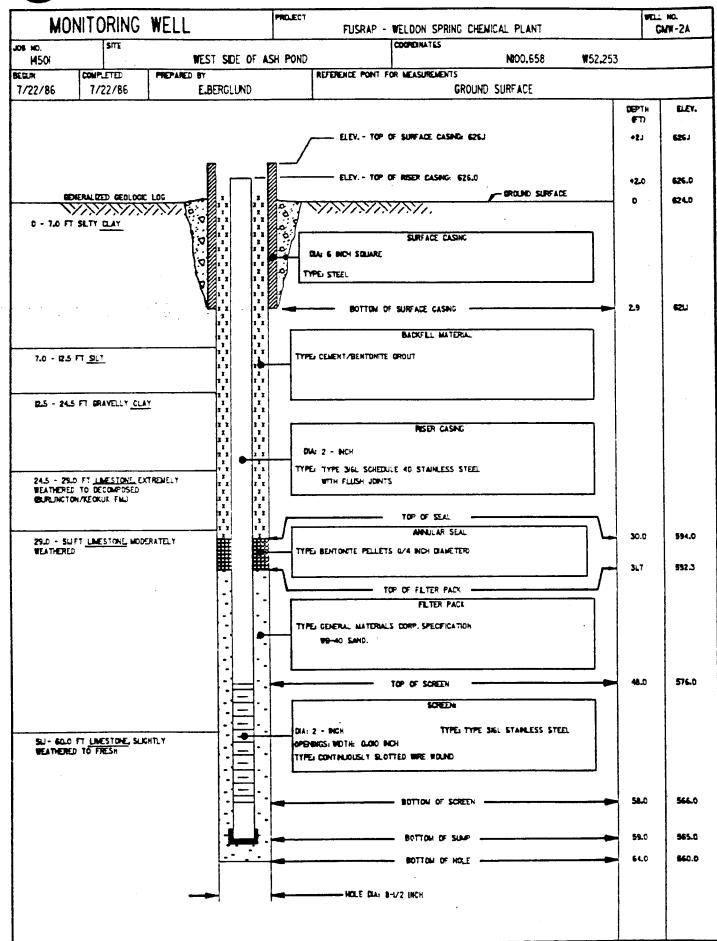
FIGURE E-1 TERRAIN CONDUCTIVITY CONTOUR MAP SHOWING AREAL LIMITS OF THE SURVEY

## APPENDIX F WELL CONSTRUCTION DATA

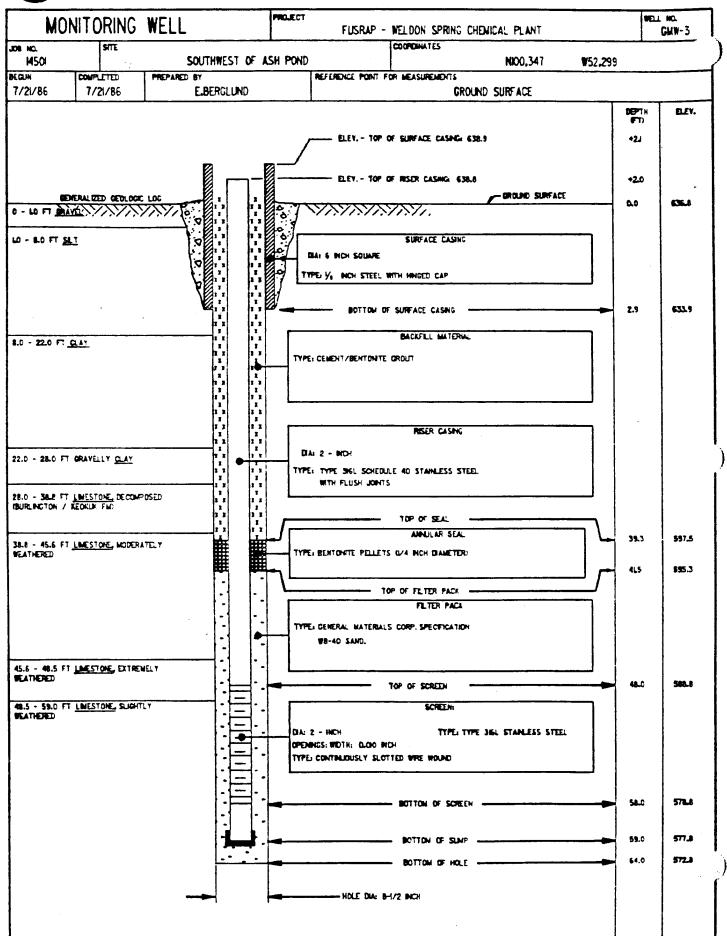




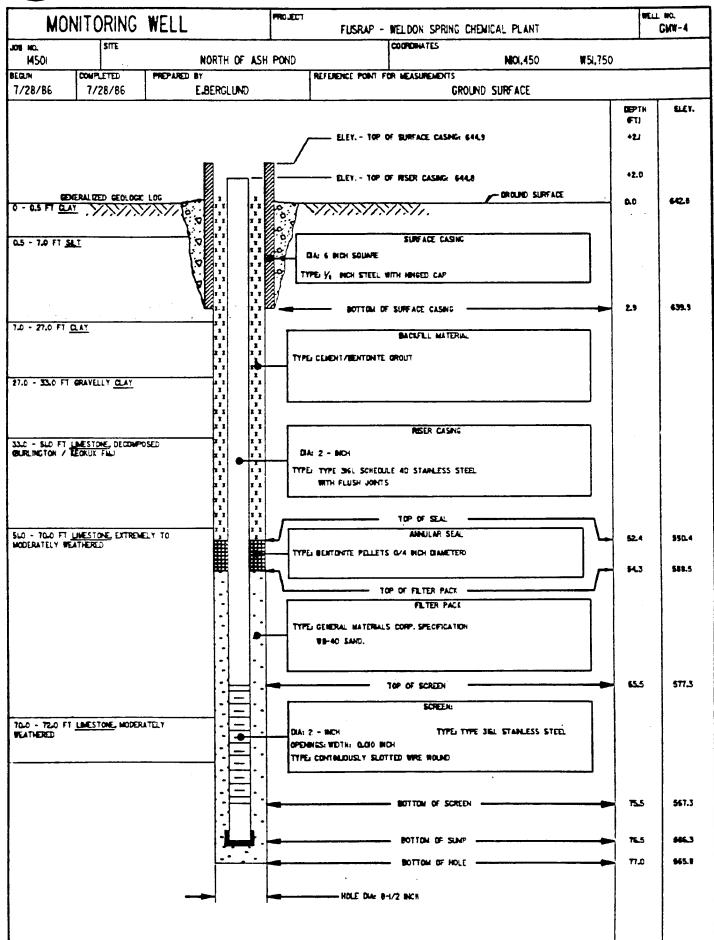




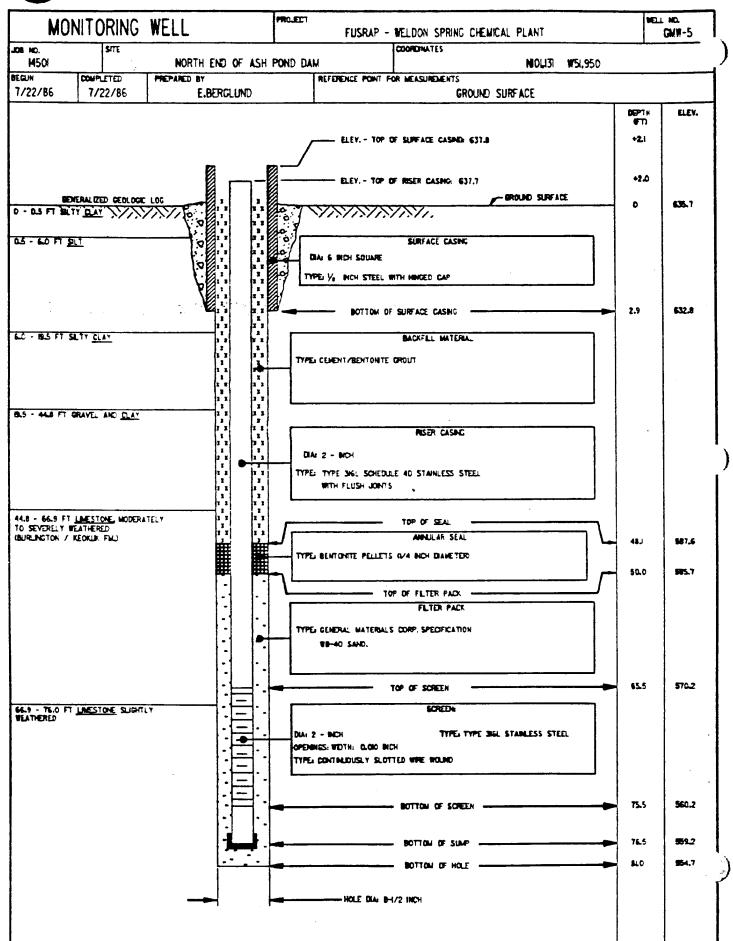




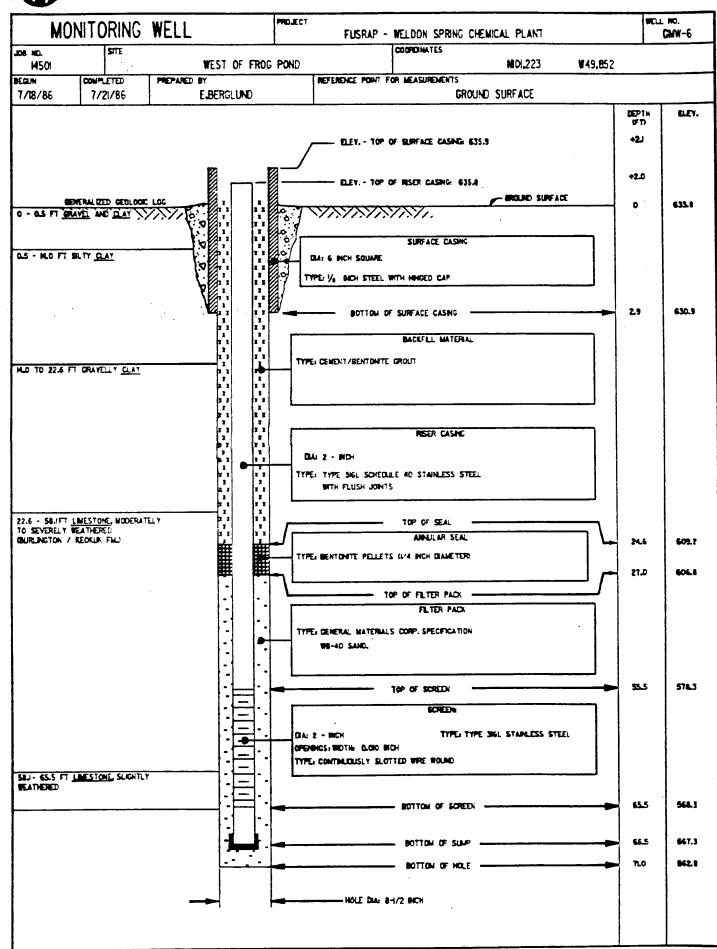




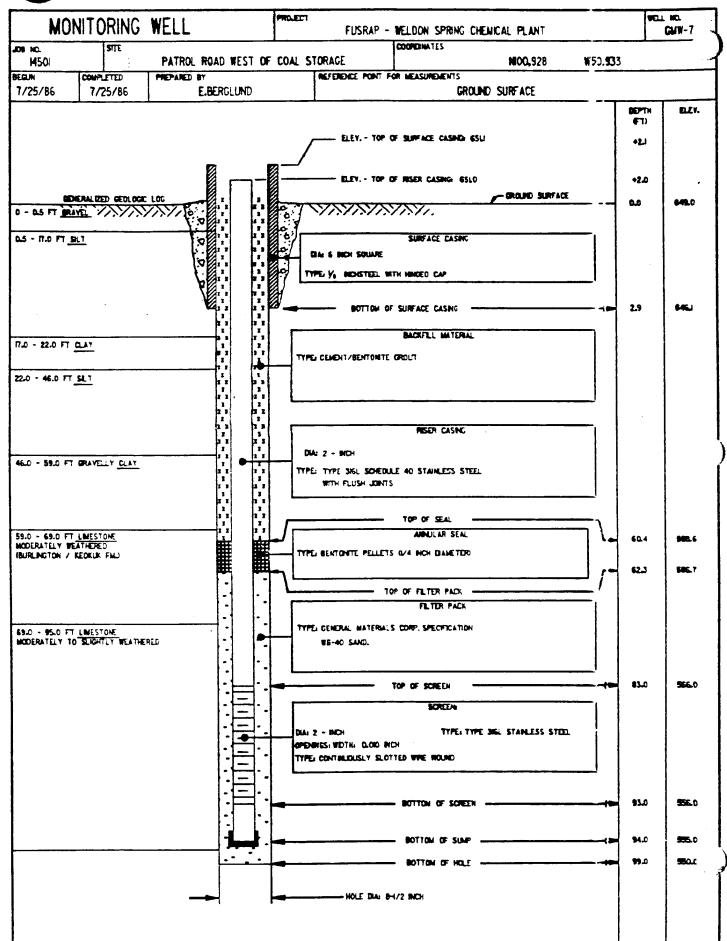




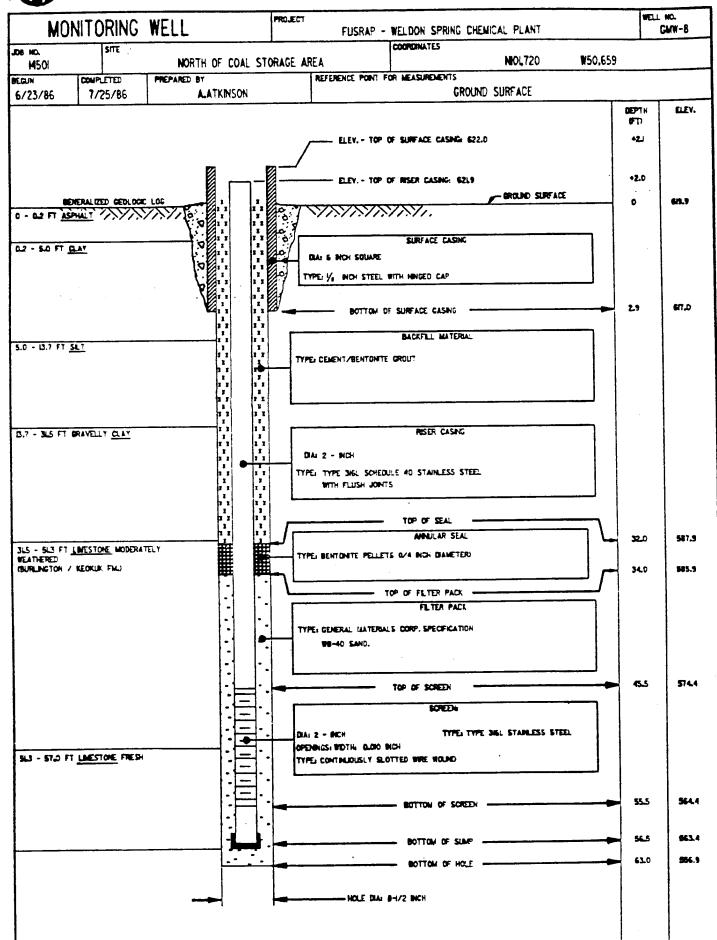






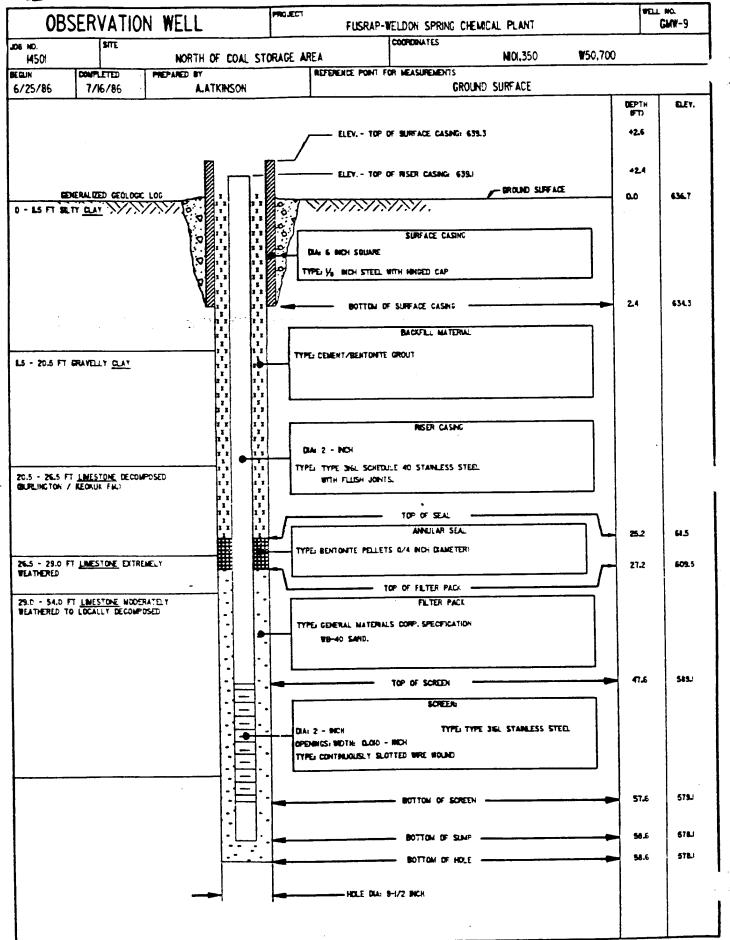




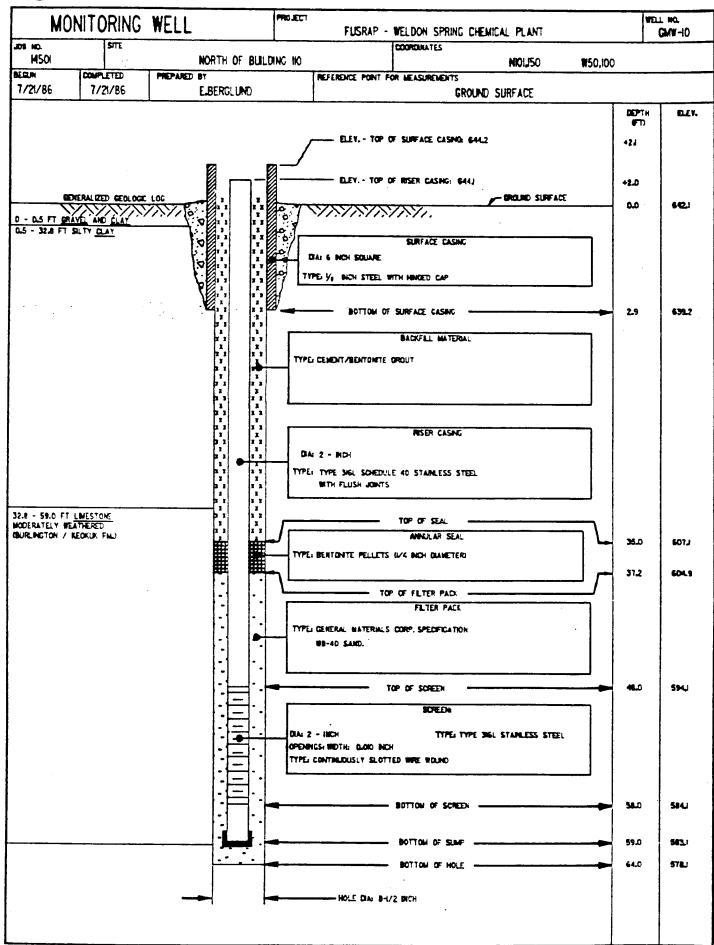


F-8

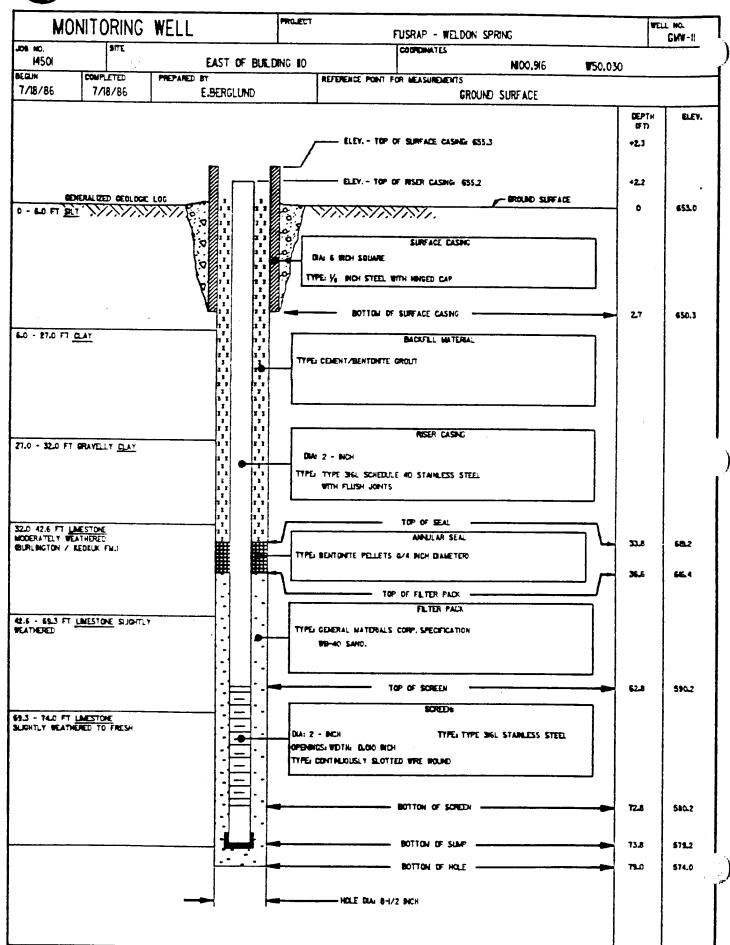




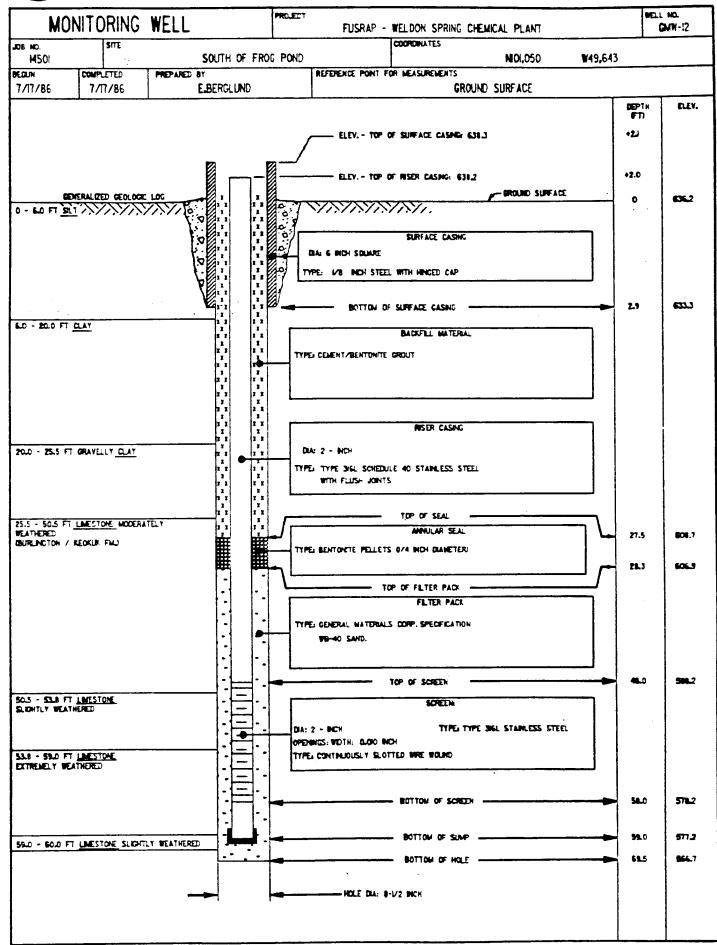




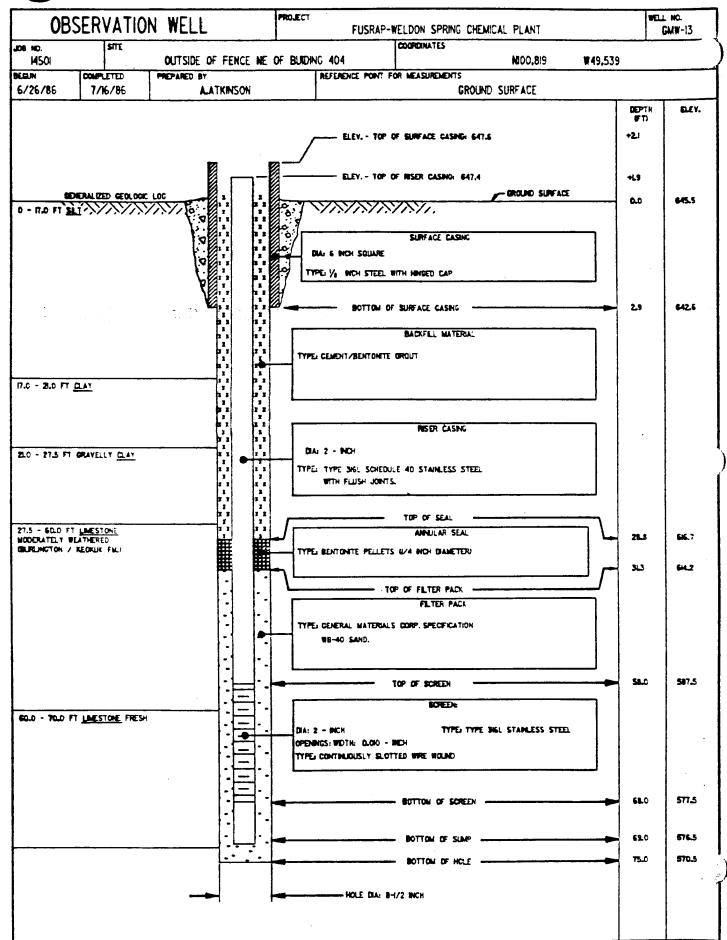




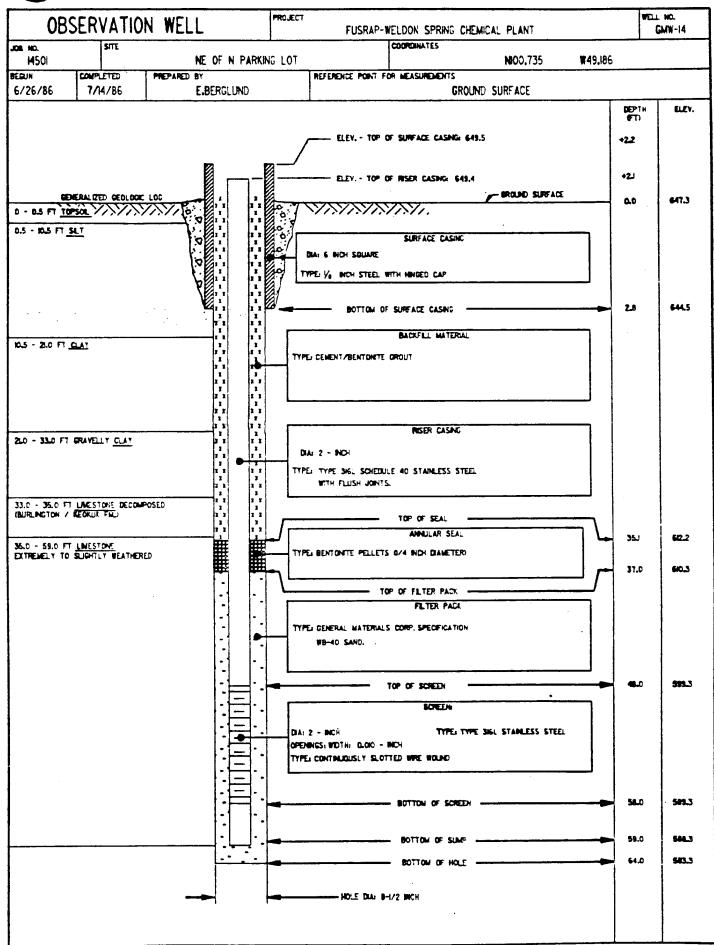




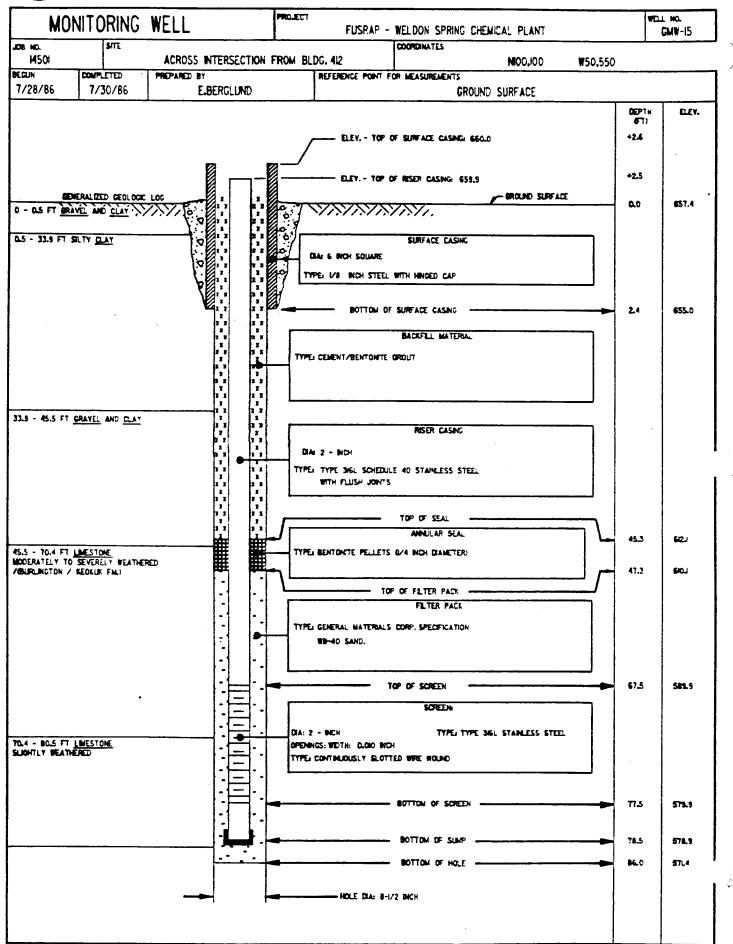






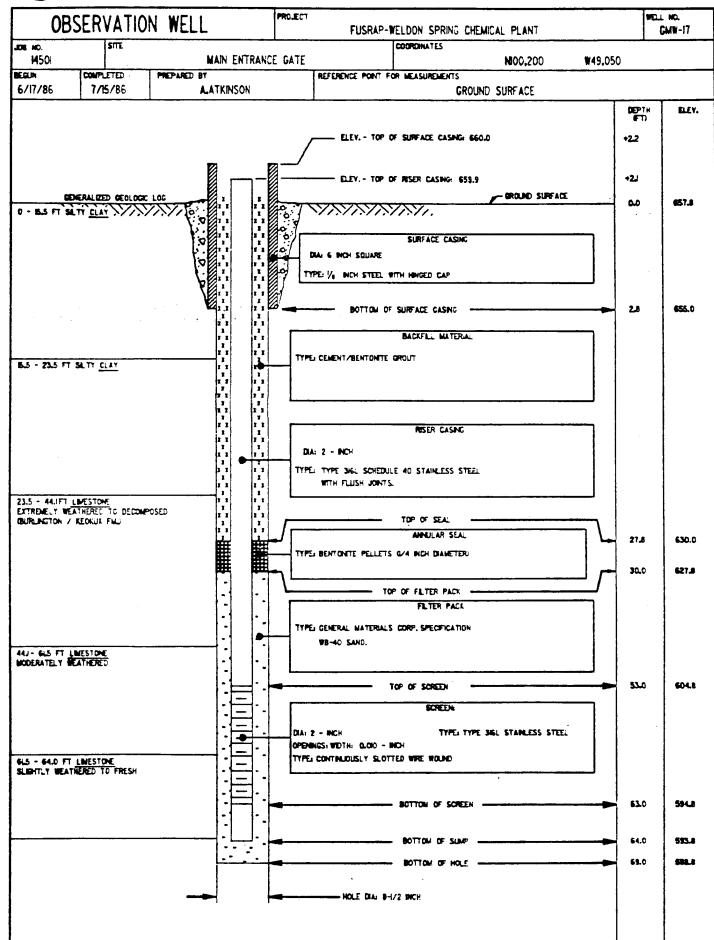




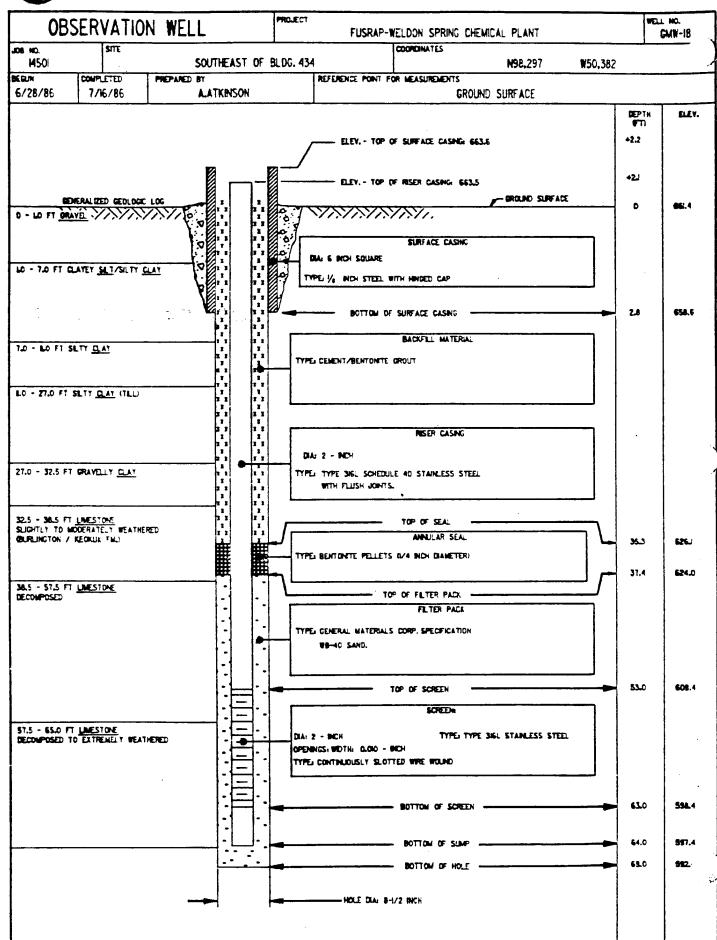


F-15









### APPENDIX G HYDROGEOCHEMICAL DATA



19161 Lackland Road, St Louis, Missouri 63146 (314) 434-6960

### REPORT OF ANALYSIS

CLIENT: Environmental Supervisor

FUSRAP

Bechtel National, Inc.

F.O. Rox 350

Oak Ridge, Tennessee 37830

REPORT DATE:

October 30,1986

SAMPLE ANALYZED: 2 groundwater samples for

radiological analyses.

DATE RECEIVED:

September 19 & 22,1986

P.O. 8:

PROJ. 0: 3060-00354

SAMPLE	(1986)	PARAMETER	VALUE
	E0111111111		<b>E</b>
201-5P-821-0386	9/20	GROSS ALPHA, pCi/l	12 +/- 4
		GROSS BETA, pCi/l	12 +/- 3
		TOTAL URANIUM, mg/l	0.018
		RADIU∺-226, pCi/l	( 0.6
		URANIUM-234, pCi/l	6.4 +/- 1.6
		URANIUM-235, pCi/l	( 0.6
		URANIUM-238, pCi/1	6.7 +/- 1.6
201-5-84 <del>-6-0</del> 0386	9/19	GROSS ALPHA, pCi/1	15 +/- 3
		GROSS BETA, pCi/l	5 +/- 3
		TOTAL URANIUM, mg/1	0.021
		RADIUM-226, pCi/l	( 0.6
		URANIUM-234, pCi/l	5.3 +/- 1.4
		URANIUM-235, pCi/l	( 0.6
		URANIUM-238, pCi/l	7.7 +/- 1.7

APPROVED:

PAGE 1 OF 1

G-1



111t1 Lecklar o Pued Stitlouis *Missour in 1*14t Revised July 14, 1987

### REPORT OF AMALYSIS

CLIENT: Mr. Jack Blanke

Bechtel National, Inc. Post Office Box 350 Oak Ridge, TN 37830

REPORT DATE:

November 24, 1986

SAMPLE AMALYZED: 13 Water Samples

DATE RECEIVED:

October 1, 1986

PROJ. #: 3060-00354

P.O. #: 

Conductivity (uMhos/cm)  pH Chloride (mg/L) Sulfate (mg/L) Carbonate (mg/L) Bicarbonate (mg/L) Mitrite (mg/L) Hitrate (mg/L) Calcium (mg/L) Hagnesium (mg/L) Holybdenum (mg/L) Potassium (mg/L) Strontium (mg/L)	1601.6 7.35 7.9 64 ( 0.5 49.6 0.82 167 210 5.45 70.2 ( 0.05 17.54 0.610 0.21	
pH Chloride(mg/L) Sulfate(mg/L) Carbonate(mg/L) Bicarbonate(mg/L) Mitrite(mg/L) Mitrate(mg/L) Calcium(mg/L) Magnesium(mg/L) Sodium(mg/L) Molybdenum(mg/L) Potassium(mg/L) Strontium(mg/L)	7.35 7.9 64 ( 0.5 49.6 0.82 167 210 5.45 70.2 ( 0.05 17.54 0.610 0.21	
Chloride(mg/L) Sulfate(mg/L) Carbonate(mg/L) Bicarbonate(mg/L) Witrite(mg/L) Witrate(mg/L) Calcium(mg/L) Hagnesium(mg/L) Sodium(mg/L) Holybdenum(mg/L) Potassium(mg/L) Strontium(mg/L)	7.9 64 ( 0.5 49.6 0.82 167 210 5.45 70.2 ( 0.05 17.54 0.610 0.21	
Sulfate(mg/L) Carbonate(mg/L) Bicarbonate(mg/L) Mitrite(mg/L) Mitrate(mg/L) Calcium(mg/L) Magnesium(mg/L) Sodium(mg/L) Molybdenum(mg/L) Potassium(mg/L) Strontium(mg/L)	64 ( 0.5 49.6 0.82 167 210 5.45 70.2 ( 0.05 17.54 0.610 0.21	
Carbonate(mg/L) Bicarbonate(mg/L) Nitrite(mg/L) Nitrate(mg/L) Calcium(mg/L) Hagnesium(mg/L) Sodium(mg/L) Molybdenum(mg/L) Potassium(mg/L) Strontium(mg/L)	( 0.5 49.6 0.82 167 210 5.45 70.2 ( 0.05 17.54 0.610 0.21	
Bicarbonate(mg/L) Mitrite(mg/L) Mitrate(mg/L) Calcium(mg/L) Magnesium(mg/L) Sodium(mg/L) Molybdenum(mg/L) Potassium(mg/L) Strontium(mg/L)	49.6 0.82 167 210 5.45 70.2 ( 0.05 17.54 0.610 0.21	
Mitrite(mg/L) Nitrate(mg/L) Calcium(mg/L) Magnesium(mg/L) Sodium(mg/L) Molybdenum(mg/L) Potassium(mg/L) Strontium(mg/L)	0.82 167 210 5.45 70.2 ( 0.05 17.54 0.610 0.21	
Mitrate(mg/L) Calcium(mg/L) Magnesium(mg/L) Sodium(mg/L) Molybdenum(mg/L) Potassium(mg/L) Strontium(mg/L)	167 210 5.45 70.2 ( 0.05 17.54 0.610 0.21	
Calcium(mg/L) Magnesium(mg/L) Sodium(mg/L) Molybdenum(mg/L) Potassium(mg/L) Strontium(mg/L)	210 5.45 70.2 ( 0.05 17.54 0.610 0.21	
Magnesium (mg/L) Sodium (mg/L) Molybdenum (mg/L) Potassium (mg/L) Strontium (mg/L)	5.45 70.2 ( 0.05 17.54 0.610 0.21	
Sodium(mg/L) Molybdenum(mg/L) Potassium(mg/L) Strontium(mg/L)	70.2 ( 0.05 17.54 0.610 0.21	
Molybdenum (mg/L) Potassium (mg/L) Strontium (mg/L)	( 0.05 17.54 0.610 0.21	
Potassium (mg/L) Strontium (mg/L)	17.54 0.610 0.21	
Strontium (mg/L)	0.610 0.21	
<del>_</del>	0.21	
	****	
Lithium(mg/L)		
Vanadium(mg/L)	<b>( 0.0</b> 50	
Hardness (mg/L, CaCO3)	547	
Oxidation-Reduction Potencial(mv)	) <b>33</b> 3	
201-SP-GMW3-G-386 Conductivity(wMhos/cm)	<b>25</b> 51.4	
<del>pi</del> l	7.81	
Chloride(mg/L)	13	
Sulfate(mg/L)	210	
Carbonate(mg/L)	( 0.5	
Bicarbonate(mg/L)	237.8	
Nitrite(mg/L)	( 0.05	
Mitrate(mg/L)	236	
Calcium(mg/L)	235	
Magnesium (mg/L)	84.6	
Sodium (mg/L)	57.2	
Molybdenus (mg/L)	( 0.05	
Potassium (mg/L)	10.54	
Strontium(mg/L)	0.723	
Lithium (mg/L)	0.45	
Vanadium(mg/L)	0.025	
Hardness (eg/L, CaCO3)	<b>%</b> 2	
Ozidation-Reduction Poteneial(sv		
PAGE 1 OF 7		

### REPORT OF AMALYSIS

CLIENT: Mr. Jack Blanke

Bechtel Mational, Inc. Post Office Box 350 Oak Ridge, TN 37830

REPORT DATE:

Hovesber 24, 1986

SAMPLE AMALYZED: 13 Water Samples

BATE RECEIVED: October 1, 1986

PROJ. #: 3060-00354 

P.O. #:

SAMPLE	AMALYSIS	RESULT
<del> </del>   201-SP <del>-G</del> MW4-G-386	Conductivity (uMhos/ca)	619.9
EQT SP GIMA C 300	pH	7.81
	Chloride(mg/L)	4
	Sulfate(mg/L)	13
	Carbonate (mg/L)	( 0.5
i	Bicarbonate (mg/L)	<b>3</b> 50
	Witrite(mg/L)	( 0.05
	Nitrate(mg/L)	1.20
	Calcium (mg/L)	59.2
	Magnesium (mg/L)	39.6
	Sodius (ng/L)	14.4
	Molybdenus (sg/L)	( 0.05
	Potassium (mg/L)	1.76
	Strontium (mg/L)	0.305
	Lithium (mg/L)	( 0.03
	Vanadium (mg/L)	0.084
	Hardness (mg/L, CaCO3)	320
	Oxidation-Reduction Potencial(sv)	<b>2</b> 29
01-SP-GHW5-G-386	Conductivity (uMhos/cm)	1794.7
	Ha	7.64
	Chloride(mg/L)	9.€
	Sulfate(mg/L)	76
	Carbonate(mg/L)	( 0.5
	Bicarbonate(mg/L)	83.2
	Nitrite(mg/L)	⟨ 0.05
	Nitrate(mg/L)	185
	Calcium(mg/L)	182
	Magnesium (mg/L)	49.0
	Sodium (mg/L)	71.5
	Holybdenum (mg/L)	( 0.05
	Potassium (mg/L)	9.96
	Strontium (mg/L)	0.722
	Lithium(mg/L)	0.27
	Vanadium (mg/L)	( 0.050
	Mardness (mg/L, CaCO3)	656
	Oxidation Reduction Potencial (mv) PAGE 2 OF 7	<b>3</b> 21

### REPORT OF AMALYSIS

CLIENT: Mr. Jack Blanke

Bechtel National, Inc. Post Office Box 350 Bak Ridge, TN 37830

REPORT DATE: November 24, 1986

SAMPLE AMALYZED: 13 Mater Samples

BATE RECEIVED: October 1, 1986

PROJ. #: 3060-00354 

SAMPLE	ANALYSIS	RESULT
	*******	*********
01-SF-GMW8-G-386	Conductivity (uMhos/cm)	6837.0
	pН	7.76
	Chloride(mg/L)	50.4
	Sulfate(mg/L)	59
	Carbonate (mg/L)	( 0.5
	Bicarnonate(mg/L)	271
	Nitrite(mg/L)	( 0.05
	Mitrate(mg/L)	( 0.05
	Calcium(mg/L)	83.1
	Ragnesius (sg/L)	<b>33.</b> 1
	Sodium(mg/L)	18.0
	Molybdenum (mg/L)	( 0.05
	Potassium(mg/L)	3.13
	Strontium(mg/L)	0.246
	Lithium(mg/L)	( 0.03
	Vanadium(mg/L)	( 0.050
	Hardness (mg/L, CaCO3)	<b>35</b> 6
	Oxidation-Reduction Potencial(mv)	298
01-SP-RP1-W-386	Conductivity (uMhos/cm)	<b>35</b> 15.8
201 Bt W. 1 m 200	Ph	8.01
	Chloride(mg/L)	<b>2</b> 7.2
	Sulfate(mg/L)	315
	Carbonate (mg/L)	( 0.5
	Bicarbonate	50.8
	Nitrite(mg/L)	1.78
	Nitrate(ng/L)	404
	Calcium (mg/L)	<b>3</b> 61
	Magnesium (mg/L)	19.2
	Sodius(ag/L)	420
	Molybdenus (sg/L)	3.34
	Potassium(mg/L)	38.00
		1.04
	Strontium(mg/L)	(0.03
	Lithium (mg/L)	2.38
	Vanadium (mg/L)	936
	Hardness (mg/L, CaCO3)	300
	Oxidation-Reduction Potencial(ev) PAGE 3 OF 7	
		, 

### REPORT OF ANALYSIS

CLIENT: Mr. Jack Blanke

Bechtel Mational, Inc. Post Office Box 350 Oak Ridge, TN 37830

REPORT DATE:

November 24, 1986

SAMPLE AMALYZED: 13 Water Samples

BATE RECEIVED:

October 1, 1986

PROJ. 8: 3060-00354

P.O. #: 

SAMPLE	ANALYSIS	RESULT
	STEERSEE	425.5
201-SP-RP2-W-386.	Conductivity (uMhos/cm)	8.63
	<b>pH</b>	6.2
	Chloride(ag/L)	796
	Sulfate(mg/L)	(0.5
	Carbonate(mg/L)	39
	Bicarbonate(mg/L)	= -
	Nitrite(mg/L)	<b>0.5</b> 5 <b>10.</b> 13
	Nitrate(mg/L)	10.13
	Calcium(mg/L)	
	Magnesium(mg/L)	46.9
	Sodium (mg/L)	78
	Holybdenum(mg/L)	6.67
	Potassium(mg/L)	20.00
	Strontius (mg/L)	<b>0.3</b> 53
	Lithium(mg/L)	( 0.03
	Vanadium(mg/L)	1.41
	Hardness(mg/L,CaCB3)	470
	Oxidation Reduction Potencial(mv)	278
)1-SP-RP3-W-386	Conductivity(uMhos/cm)	9449.5
	<del>pH</del>	8.06
	Chloride(mg/L)	<b>3</b> 6.3
	Sulfate(mg/L)	495
	Carbonate(mg/L)	( 0.5
	Bicarbonate(mg/L)	50
	Nitrite(mg/L)	2.69
	Nitrate(mg/L)	1170
	Calcium(mg/L)	420
	Magnesium (mg/L)	311
	Sodium (mg/L)	<b>76</b> 7
	Molybdenum (mg/L)	3.96
	Potassium(mg/L)	105.95
	Strontium (mg/L)	1.76
	Lithium(mg/L)	2.79
	Vanadium(mg/L)	0.548
	_	2461
		354
	PAGE 4 OF 7	
*********************	Hardness (mg/L, CaCO3) Oxidation—Reduction Potencial (mv)	<b>24</b> 61 <b>3</b> 54

### REPORT OF AMALYSIS

CLIENT: Mr. Jack Blanke

Bechtel National, Inc. Post Office Box 350 Oak Ridge, TN 37830

REPORT DATE:

November 24, 1986

SAMPLE ANALYZED: 13 Water Samples

DATE RECEIVED: October 1, 1986

PROJ. #: 3060-00354

SAMPLE	ANALYSIS	RESULT
***************************************	EE:::::::	22111111
201-SP-B2-G-386	Conductivity (uMhos/cm)	<b>9</b> 77.1
	pH	7. <b>9</b> 0
	Chloride(mg/L)	4
	Sulfate(mg/L)	56
	Carbonate(mg/L)	⟨ 0.5
	Bacarbonate(mg/L)	128.6
	Nitrite(mg/L)	( 0.05
	Mitrate(mg/L)	88.8
•	Calcium(mg/L)	102
	Magnesius(mg/L)	<b>5</b> 3.9
	Sodium (mg/L)	19.4
	Molybdenus(mg/L)	( 0.05
	Potassium(mg/L)	1.24
	Strontium(mg/L)	0.212
	Lithium(mg/L)	( 0.03
	Vanadium(mg/L)	( 0.050
	Hardness (mg/L, CaCO3)	493
	Oxidation-Reduction Potencial(mv)	298
-SP-B19A-G-386	Conductivity (uMhos/cm)	7368.4
<del></del>	PΗ	7.17
	Chloride(mg/L)	<b>2</b> 2.1
	Sulfate(mg/L)	57
	Carbonate(mg/L)	( 0.5
	Bicarbonate(mg/L)	251.6
	Mitrite(mg/L)	0.06
	Hitrate(mg/L)	870
	Calcium (mg/L)	<b>9</b> 51
	Magnesium (mg/L)	250
	Sodium (mg/L)	284
	Holybdenum (mg/L)	( 0.05
	Potassium (mg/L)	3.54
	Strontium(mg/L)	2.57
	Lithium(mg/L)	0.22
	Vanadium (mg/L)	0.064
	Hardness (mg/L, CaCO3)	3448
	Oxidation-Reduction Potencial (mv)	336
	PAGE 5 OF 7	950

### REPORT OF AMALYSIS

CLIENT: Mr. Jack Blanke

Bechtel National, Inc. Post Office Box 350 Oak Ridge, TN 37830

REPORT DATE:

November 24, 1986

SAMPLE AMALYZED: 13 Water Samples

BATE RECEIVED: October 1, 1986

PROJ. 8: 3060-00354

Conductivity (uWhos/cm)   5597.9	SAMPLE	ANALYSIS	RESULT
Conductivity (Name of the Conductivity (Na	**********		
Chloride(mg/L)	201-SP-GHW11-G-386	Conductivity (uMhos/cm)	<del>-</del> - ·
Sulfate (mg/L)			
Sultate (mg/L)		•	
Bicarbonate(mg/L)			
Nitrite(mg/L)			
Mitrate (mg/L) 4.13 Calcium (mg/L) 61.3 Magnesium (mg/L) 30.7 Sodium (mg/L) 10.4 Molybdemum (mg/L) (0.05 Potassium (mg/L) (0.05 Strontium (mg/L) (0.03 Vanadium (mg/L) (0.03 Vanadium (mg/L) (0.050 Mardness (mg/L, CaCO3) 438 Didation-Reduction Potencial (mv) 297  201-SP-B23-G-386  Conductivity (mMhos/cm) 7352.8 pH Chloride (mg/L) 1.7 Sulfate (mg/L) 13 Carbonate (mg/L) (0.05 Mitrate (mg/L) 365 Mitrite (mg/L) 1.7 Sulfate (mg/L) 1.7 Sulfate (mg/L) 365 Mitrite (mg/L) 365 Mitrite (mg/L) 365 Mitrite (mg/L) 1.10 Calcium (mg/L) 47 Magnesium (mg/L) 53.1 Sodium (mg/L) 26.3 Molybdemum (mg/L) 26.3 Molybdemum (mg/L) 0.94 Strontium (mg/L) 0.210 Lithium (mg/L) (0.050			
Calcium(mg/L) 61.3  Hagnesium(mg/L) 30.7  Sodium(mg/L) 10.4  Molybdenum(mg/L) (0.05  Potassium(mg/L) 0.116  Lithium(mg/L) (0.03  Vanadium(mg/L) (0.050  Hardness(mg/L,CaC03) 438  Oxidation-Reduction Potencial(mv) 297  201-SP-B23-G-386  Conductivity(uMhos/cm) 7352.8  pH 8.18  Chloride(mg/L) 1.7  Sulfate(mg/L) 1.7  Sulfate(mg/L) 365  Bicarbonate(mg/L) 365  Hitrite(mg/L) 365  Hitrite(mg/L) 1.10  Calcium(mg/L) 47  Hagnesium(mg/L) 53.1  Sodium(mg/L) 26.3  Molybdenum(mg/L) 26.3  Molybdenum(mg/L) 0.94  Strontium(mg/L) 0.210  Lithium(mg/L) 0.210  Lithium(mg/L) 0.050			•
Hagnesium(mg/L)   30.7     Sodium(mg/L)   10.4     Holybdenum(mg/L)   (0.05     Potassium(mg/L)   3.76     Strontium(mg/L)   (0.116     Lithium(mg/L)   (0.03     Vanadium(mg/L)   (0.050     Mardness(mg/L, CaCO3)   438     Dxidation-Reduction Poteneial(mv)   297     201-SP-B23-G-386   Conductivity(uMhos/cm)   7352.8     pH			
Sodium(mg/L)			
Molybdenum(mg/L) (0.05 Potassium(mg/L) 3.76 Strontium(mg/L) 0.116 Lithium(mg/L) (0.03 Vanadium(mg/L) (0.050 Hardness(mg/L, CaCO3) 438 Oxidation-Reduction Potencial(mv) 297  201-SP-B23-G-386  Conductivity(uMhos/cm) 7352.8 pH 8.18 Chloride(mg/L) 1.7 Sulfate(mg/L) 1.7 Sulfate(mg/L) (0.5 Bicarbonate(mg/L) 365 Hitrite(mg/L) (0.05 Hitrate(mg/L) 1.10 Calcium(mg/L) 1.10 Calcium(mg/L) 47 Magnesium(mg/L) 26.3 Holybdenum(mg/L) 26.3 Holybdenum(mg/L) 0.94 Strontium(mg/L) 0.210 Lithium(mg/L) 0.210 Lithium(mg/L) (0.050			-
Potassium (mg/L) 3.76 Strontium (mg/L) 0.116 Lithium (mg/L) (0.03 Vanadium (mg/L) (0.050 Hardness (mg/L, CaCO3) 438 Oxidation-Reduction Potencial (ms/L) 297  201-SP-B23-G-386  Conductivity (uMhos/cm) 7352.8 pH 8.18 Chloride (mg/L) 1.7 Sulfate (mg/L) 1.7 Sulfate (mg/L) (0.5 Bicarbonate (mg/L) 365 Hitrite (mg/L) (0.05 Hitrate (mg/L) 1.10 Calcium (mg/L) 1.10 Calcium (mg/L) 47 Magnesium (mg/L) 26.3 Holybdenum (mg/L) 26.3 Holybdenum (mg/L) 0.94 Strontium (mg/L) 0.210 Lithium (mg/L) (0.050			
Strontium(mg/L)		Molybdenus(mg/L)	• •
Lithium(mg/L)		Potassium(mg/L)	_
Vanadium(mg/L) ( 0.050  Vanadium(mg/L) 438  Dxidation-Reduction Potencial(mv) 297  201-SP-B23-G-386  Conductivity(uMhos/cm) 7352.8  pH 8.18  Chloride(mg/L) 1.7  Sulfate(mg/L) ( 0.5  Bicarbonate(mg/L) 365  Nitrite(mg/L) ( 0.05  Nitrate(mg/L) 1.10  Calcium(mg/L) 47  Magnesium(mg/L) 53.1  Sodium(mg/L) 26.3  Holybdenum(mg/L) ( 0.05  Potassium(mg/L) ( 0.05  Potassium(mg/L) ( 0.05  Potassium(mg/L) ( 0.05  Potassium(mg/L) ( 0.05  Potassium(mg/L) ( 0.05  Vanadium(mg/L) ( 0.050		Strontium (mg/L)	
Vanablus(mg/L, CaCO3) 438		Lithium(mg/L)	
Hardness(mg/L,CaCO3)		Vanadium (mg/L)	• • • • • • •
201-SP-B23-G-386  Conductivity(uMhos/cm)  pH  Chloride(mg/L)  Sulfate(mg/L)  Carbonate(mg/L)  Bicarbonate(mg/L)  Nitrite(mg/L)  Nitrate(mg/L)  Calcium(mg/L)  Lalcium(mg/L)  Sodium(mg/L)  Sodium(mg/L)  Potassium(mg/L)  Strontium(mg/L)  Lithium(mg/L)  Lithium(mg/L)  Vanadium(mg/L)  Vanadium(mg/L)  Co.05		Hardness(mg/L,CaCO3)	· = -
Description of the conductivity (units) for pH		Oxidation-Reduction Potencial (my	<b>29</b> 7
DH	201-CD-R23-G-3A6	Conductivity (uMhos/cm)	
Chloride(mg/L) 1.7 Sulfate(mg/L) 13 Carbonate(mg/L) (0.5 Bicarbonate(mg/L) 365 Mitrite(mg/L) (0.05 Hitrate(mg/L) 1.10 Calcium(mg/L) 47 Hagnesium(mg/L) 53.1 Sodium(mg/L) 26.3 Holybdenum(mg/L) (0.05 Potassium(mg/L) 0.94 Strontium(mg/L) (0.03 Lithium(mg/L) (0.050 Vanadium(mg/L) (0.050	\$01-34 BEQ 0 000		
Sulfate (mg/L) (0.5 Carbonate (mg/L) (0.5 Bicarbonate (mg/L) (0.05 Hitrite (mg/L) (0.05 Hitrate (mg/L) (0.05 Calcium (mg/L) 47 Calcium (mg/L) 53.1 Sodium (mg/L) 26.3 Holybdenum (mg/L) (0.05 Potassium (mg/L) 0.94 Strontium (mg/L) (0.03 Lithium (mg/L) (0.05 Vanadium (mg/L) (0.050		<b>T</b>	
Carbonate (mg/L)		•	
Bicarbonate (mg/L) 365  Mitrite (mg/L) ( 0.05  Mitrate (mg/L) 1.10  Calcium (mg/L) 47  Magnesium (mg/L) 53.1  Sodium (mg/L) 26.3  Holybdenum (mg/L) ( 0.05  Potassium (mg/L) 0.94  Strontium (mg/L) ( 0.03  Lithium (mg/L) ( 0.050  Vanadium (mg/L) ( 0.050			• • • • •
Nitrite(mg/L)			•••
Hitrate(mg/L) 1.10  Calcium(mg/L) 47  Hagnesium(mg/L) 53.1  Sodium(mg/L) 26.3  Holybdenum(mg/L) (0.05  Potassium(mg/L) 0.94  Strontium(mg/L) (0.03  Lithium(mg/L) (0.03  Vanadium(mg/L) (0.050			( 0.05
Calcium(mg/L)  Magnesium(mg/L)  Sodium(mg/L)  Molybdenum(mg/L)  Potassium(mg/L)  Strontium(mg/L)  Lithium(mg/L)  Vanadium(mg/L)  (0.05  (0.03)  (0.050)			1.10
Hagnesium(mg/L)			**
Sodium (mg/L) 26.3  #folybdenum (mg/L) ( 0.05  Potassium (mg/L) 0.210  Strontium (mg/L) ( 0.03  Vanadium (mg/L) ( 0.050			<del>-</del>
## ## ## ## ## ## ## ## ## ## ## ## ##			
Potassium(mg/L) 0.94 Strontium(mg/L) 0.210 Lithium(mg/L) (0.03 Vanadium(mg/L) (0.050			
Strontium(mg/L) 0.210 Lithium(mg/L) (0.03 Vanadium(mg/L) (0.050			
Lithium(mg/L) ( 0.03 Vanadium(mg/L) ( 0.050			
Vanadium(mg/L) (0.050			
			<b>( 0.0</b> 50
		Hardness (mg/L, CaCO3)	340
Oxidation-Reduction Potencial(mg) 300  PAGE 6 OF 7		Oxidation-Reduction Potencial (m)	, ••••

REPORT OF AMALYSIS

CLIENT: Mr. Jack Blanke

Bechtel National, Inc. Post Office Box 350 Oak Ridge, TN 37830 REPORT DATE:

November 24, 1986

SAMPLE AMALYZED: 13 Water Samples

268

DATE RECEIVED:

October 1, 1986

PROJ. #: 3060-00354

D.O. 8:

SAMPLE	<b>ANALYS</b> IS	RESULT
Extraction . ,	********	######################################
201-SP-B11-G-386	Conductivity (unhos/cm)	450.0
	pH .	8.11
	Chloride(mg/L)	6.8
	Sulfate(mg/L)	38
	Carbonate (mg/L)	( 0.5
	Bicarbonate(mg/L)	260.4
	Mitrite(mp/L)	⟨ 0.05
	Mitrate(mg/L)	1.50
	Calcium(mg/L)	61.9
	Magnesium(mg/L)	34.5
	Sodium(mg/L)	11
	Molybdenua (ag/L)	( 0.05
	Potassium(mg/L)	1.18
	Strontium(mg/L)	0.103
	Lithium(mg/L)	( 0.03
	Vanadium (mg/L)	( 0.050
	Hardness (mg/L, CaCO3)	<b>28</b> 6

Attachment I "STANDARD CLAUSES" is included herein by reference.

Oxidation-Reduction Potencial(mv)

APPROVED:

PAGE 7 OF 7

### ATTACHMENT I - STANDARD CLAUSES

ENVIRODYNE ENGINEERS, INC.

CLIENT: Bechtel National, Inc.

REPORT DATE:

November 24, 1986

The testing services provided herein have been performed, findings obtained, and reports prepared in accordance with generally accepted testing laboratory principles and practices. This warrenty is in lieu of all other warrenties, either expressed or implied.

These tests were conducted in accordance with the standards and procedures specified. Interpretations of the results should take into account that there is a generally recognized and accepted degree of error associated with these and all laboratory analytical tests.

These analyses have been made (tests performed) and report prepared based upon the specific sample(s) provided to us by the client or his/her representative for testing. We assume no responsibility for variations in quality, composition, appearance, performance, etc. or any other feature of similar subject matter produced, manufactured, fabricated, etc. by persons or under conditions over which we have no control.

Samples will not be held by the laboratory for more than 60 days after the date of receipt. Any extension of this time must be evidenced by written agreement between the laboratory and the client.

This REPORT OF ANALYSIS is furnished in strict confidence for the exclusive use of the client and his/her representatives, and no distribution of all or part of the report shall be made to third parties without the prior written approval of Envirodyne Engineers, Inc. (EEI).



12161 Lackland Road, St. Louis, Missouri 6314c (314) 434-6960

### REPORT OF ANALYSIS

CLIENT: Environmental Supervisor

FUSRAP

Bechtel National, Inc.

P. D. Box 350

Oak Ridge, Tennessee 37830

REPORT DATE:

November 17, 1986

SAMPLE ANALYZED: 2 Samples for radiological

analysis

DATE RECEIVED:

October 8, 1986

PRDJ. 8: 3060-00354

P.O. :

14501-201-SC-171

SAMPLE 201-SP	SAMPLE DATE (1986)	PARAMETER	VALUE
P14 C 0205	10/5	COOCC OF DUOC: ()	1 2
B11 <del>-6-</del> 0386	10/6	GROSS ALPHA, pCi/1 GROSS BETA, pCi/1	( 2 6 +/- 3 0,002
		TOTAL URANIUM, mg/l RADIUM 226, pCi/l	( 0.6
		URANIUM 234, pCi/l	1.72 +/- 0.31
		URANIUM 235, pCi/l	0.07 +/- 0.03
		URANIUM 236, pCi/1	0.50 +/- 0.20
B17 <del>-G-</del> 0386	10/6	6ROSS ALPHA, pCi/1	( 2
		GROSS BETA, pCi/l	24 +/- 4
		TOTAL URANIUM, mg/l	0.006
		RADIUM 226, pCi/l	( 0.6
		URANIUM 234, pCi/l	5.00 +/- 1.70
		URANIUM 235, pCi/1	0.20 +/- 0.10
		URANIUM 238, pCi/1	1.35 +/- 0.20

reduct & Orche

PAGE 1 OF 1



12161 Lackland Road, St. Louis, Missoure 6314c (314) 434-6960

### REPORT OF ANALYSIS

CLIENT: Environmental Supervisor

**FUSRAP** 

Bechtel National, Inc.

P.O. Box 350

Oak Ridge, Tennessee 37830

PROJ. #: 3060-00354

P.O. #:

REPORT DATE: October 27,1986

SAMPLE ANALYZED: 11 groundwater sample for

radiological analysis.

DATE RECEIVED: Sep

September 23, 1986

METHODS USED: Done by CEP using EPA-

Approvable methodologies.

SAMPLE 201-SP-6MM		PARMETER	VALUE
12 <b>-6-9038</b> 6	9/20	6ROSS ALPHA, pCi/l	**************************************
	2.20	GROSS BETA, pCi/l	(3
		TOTAL URANIUM, mg/1	· -
		RADIUM-226, pCi/1	( 0.6
14-6-20386	9/20	BROSS ALPHA, pCi/1	10 +/- 5
		GROSS BETA, pCi/1	6 +/- 3
		TOTAL URANIUM, mg/l	0.009
		RADIUM-226, pCi/l	2.2 +/- 0.8
13-6-00386	9/20	GROSS ALPHA, pCi/l	10 +/- 7
		GROSS BETA, pCi/i	8 +/- 3
		TOTAL URANIUM, mg/1	0.009
		RADIUM-226, pCi/l	2.0 +/- 0.6
10 <b>-6-9</b> 0386	9/20	GROSS ALPHA, pCi/1	12 +/- 7
		GROSS BETA, pCi/l	8 +/- 3
		TOTAL URANIUM, mg/1	0.007
		RADIUM-226, pCi/l	3.3 +/- 0.6
1 <b>8-6-0</b> 0386	9/21	GROSS ALPHA, pCi/l	19 +/- 9
		GROSS BETA, pCi/l	23 +/- 4
		TOTAL URANIUM, mg/1	0.011
		RADIUM-226, pCi/l	5.3 +/- 0.9
15-6-00386	9/21	GROSS ALPHA, pCi/l	( 2
		GROSS BETA, pCi/l	4 +/- 3
		TOTAL URANIUM, mg/l	0.008
		RADIUM-226, pCi/l	( 0.6

REPORT OF ANALYSIS - PAGE 2

QLIENT: Environmental Supervisor

3060-00354

FUSRAP

Bechtel National, Inc.

P.O. Box 350

Oak Ridge, Tennessee 37830

Sanple 201-Sp-6MH	SAMPLE DATE (1986)	Parameter	VALUE	
7.00200	9/21	GROSS ALPHA, pCi/l	14 +/- 8	
<b>7-6-2</b> 0386		GROSS BETA, pCi/1		
		TOTAL URANIUM, mg/1	0.011	
		RADIUM-226, pCi/l		
9 <del>-6</del> -00386	9/21	GROSS ALPHA, pCi/l	6 +/- 5	
		GROSS BETA, pCi/l	5 +/- 3	
		TOTAL URANIUM, mg/1	0.006	
		RADIUM-226, pCi/I	( 0.6	
1 <del>-6-</del> 00386	9/21	GROSS ALPHA, pCi/l	25 +/- 9	
		GROSS BETA, pCi/1	18 +/- 4	
		TOTAL URANIUM, mg/1	0.011	
		RADIUM-226, pCi/l	3.5 +/- 0.8	
6 <del>-6-</del> 00386	9/21	GROSS ALPHA, pCi/l	( 2	
		GROSS BETA, pCi/l	13 +/- 3	
		TOTAL URANIUM, mg/l	0.004	
		RADIUM-226, pCi/l	( 0.6	
21-6-20386	9/20	GROSS ALPHA, pCi/l	9 +/- 4	
		GROSS BETA, pCi/1	12 +/- 3	
		TOTAL URANIUM, mg/l	0.026	
		RADIUM-226, pCi/l	( 0.6	

APPROVED:

PAGE 5 DF 5

G-12

CUSTOMER ATTENTION

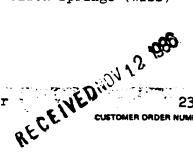
Bechtel National, Inc.-Weldon Springs (WISS)

Jeff Brown

ADDRESS P.O. Box 350 CITY

Oak Ridge, TN 37830

W.O. NO. E-6275



Radiochemical analysis of water TYPE OF ANALYSIS

23-831 CUSTOMER ORDER NUMBER

SAMPLES RECEIVED

10/2/86

ustomer lentification	Date Collected	Type of Analysis	Total Vol.	ug/l	pCi/l
201-SP-GMW2-G-386	9/30/86	Dis-Gross Alpha Dis-Gross Beta Dis-Uranium	4270	<b>&lt;</b> 5	<5 26±7
		Dis-Ra-226			0.3±0.1
201-SP-GWM3-G-386	tt	Dis-Gross Alpha Dis-Gross Beta Dis-Uranium	2990	<b>&lt;</b> 5	<5 20±8
		Dis-Ra-226			0.5±0.1
201-SP-GWM4-G-386	#8	Dis-Gross Alpha	4150		. <5
		Dis-Gross Beta			<5
		Dis-Uranium Dis-Ra-226		<b>&lt;</b> 5	0.3±0.1
201-SP-GWM5-G-386	11	Dis-Gross Alpha	4290		<5
		Dis-Gross Beta			21±8
		Dis-Uranium Dis-Ra-226		<b>&lt;</b> 5	0.5±0.1
201-SP-GWM8-G-386	11	Dis-Gross Alpha	4250		<b>&lt;</b> 5
		Dis-Gross Beta Dis-Uranium		45	17±7
		Dis-Ra-226		<5	<0.1
201-SP-RP1-W-386	11	Dis-Gross Alpha	4000		190±40
		Dis-Gross Beta		٠.	91±12
		Dis-Uranium Dis-Ra-226		41	57±6
201-SP-RP2-W-386	11	Dis-Gross Alpha	2870		590±50
		Dis-Gross Beta Dis-Uranium		130	<b>250±20</b>
		Dis-Ra-226		130	40±4
201-SP-RP3-W-386		Dis-Gross Alpha	3810		230±50
		Dis-Gross Beta Dis-Uranium		120	410±30
		Dis-Granium Dis-Ra-226		130	120±10
REPORTED VIA TELEPHONE			$\sim$		AGE OF PA

INA Eberline Thermo Analytical Inc.

7021 PAN AMERICAN FREEWAY, N.E. ALBUQUERQUE, NEW MEXICO 87109 PHONE (505) 345-3461

APPROVED BY G-13

1. Meljan Rod Melgard, Mgr.

11/12/86

DAT

CUSTOMER

Bechtel National, Inc.-Weldon Springs

ATTENTION

Jeff Brown

ADDRESS

P.O. Box 350

CITY

Oak Ridge, TN 37830

V.O. NO.

E-6243



Total Uranium, Gross Alpha, Beta, Isotopic Type of ANALYSIS Uranium, Radium-226 in water

23-121

CUSTOMER ORDER NUMBER

SAMPLES RECEIVED

9/26/86

Customer Identification	Date Collected	Type of Analysis	ug/l	pCi/l
B-4	9/19/86	Uranium Gross Alpha Gross Beta U-234	28	16±9 0±5 8.5±0.7
		U-235 U-238 Ra-226		0.4±0.2 7.3±0.7 <0.3

KEUFINED YOU BE

APPROVED BY

REPORTED VIA TELEPHONE 10/1/86 by AR

**IVIA** Eberline Thermo Analytical Inc.

7021 PAN AMERICAN FREEWAY, N.E. ALBUQUEROUE, NEW MEXICO 87109 PHONE (505) 345-3461 Rod Melgard, Mgr.

PAGE 1 OF PAGE1

10/1/86

DAT

TRansmitted 12/11/8 (V)50F)

CUSTOMER Bechtel National, Inc.-Weldon Springs

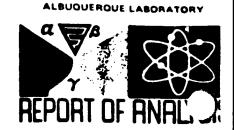
ATTENTION Jeff Brown

ADDRESS P.O. Box 350

CITY Oak Ridge, TN 37830

W.O. NO. E-6354

RECEIVED DEC 1 0 1986



Radiochemical analysis of water

, 23-831

SAMPLES RECEIVED

10/29/86

PARTIAL	REPORT
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Customer Identification	Date Collected	Type of Analysis	Total Vol.	ug/l	pCi/l
-201 R-W2-G-Q0386 -pH 7.14	9/26/86	Th-230	4230	7	0.6±0.1
201-SP-B11-G-Q0386 pH 7.02	10/6/86	Uranium Ra-226 Gross Alpha Gross Beta	<b>3</b> 520	<b>&lt;</b> 5	0.3±0.1 15±5 22±6
201-SP-B17-G-Q0386 pH 7.10	10/6/86	Uranium Ra-226 Gross Alpha Gross Beta	<b>357</b> 0	7	0.6±0.1 <15 76±9
<del>101-R-W1-G-Q-386</del> <u>pH 7.21</u>	9/26/86	Uranium Ra-226 Th-230	<del>1250</del>	<del>-&lt;5</del>	0.3±0.1 

REPORTED VIA TELEPHONE

PAGE 1 OF PAGE 1

.MA Eberline

/JZ1 PAN AMERICAN FREEWAY, N.E. ALBUQUERQUE, NEW MEXICO 87109 PHONE (505) 345-3461 APPROVED BY F

Rod Melgard, Mgr.

12/9,

DA'

CUSTOMER ATTENTION ADDRESS

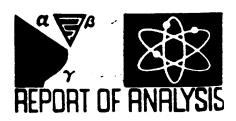
Bechtel National, Inc.-Weldon Springs

Jeff Brown

P.O. Box 350

w.o. No. DAR Ridge, TN 37830

E-6275



TYPE OF ANALYSIS

CUETOMER ORDER NUMBER

SAMPLES RECEIVED

-	Customer Identification	Date Collected	Type of Analysis	Total Vol. (ml)	ug/l	pCi/l
1	201-SP-B2-G-386	9/30/86	Dis-Gross Alpha Dis-Gross Beta	4290	0(	11±6 9±7
100			Dis-Uranium Dis-Ra-226		26	0.6±0.1
The state of the s	201-SP-B19A-G-386	11	Dis-Gross Alpha Dis-Gross Beta	4360		<5 <5
2			Dis-Uranium Dis-Ra-226		5	0.2±0.1

7021 PAN AMERICAN FREEWAY, N.E. ALBUQUEROUE, NEW MEXICO 87109 PHONE (505) 345-3461 P. Melyand

PAGE 2 11/12/86

APPROVED BY Rod Melgard, Mgr. G-14

DATE



### Department of Energy

Oak Ridge Operations
Weldon Spring Site
Remedial Action Project Office
Route 2, Highway 94 South
St. Charles, Missouri 63303

January 17, 1989

### **ADDRESSEES**

### HYDROGEOLOGIC INVESTIGATIONS SAMPLING PLAN

Enclosed is Revision 0 of the "Hydrogeologic Investigations Sampling Plan" for the Weldon Spring Site. This plan has been revised to address comments received from U. S. Environmental Protection Agency and the Missouri Department of Natural Resources as indicated in the "Responsiveness Summary", also enclosed.

Sincerely,

R. R. Nelson

Project Manager Weldon Spring Site

Remedial Action Project

Enclosures: As stated

### LIST OF ADDRESSEES FOR LETTER DATED JANUARY 17, 1989

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